INTEGRATED EDITION OF THE PETROLEUM ENGINEER

PETROLEUM Engineer for MANAGEMENT

APRIL 1961
CONTENTS: 1 AD INDEX: 4
ONE DOLLAR PER COPY

AUSTRALIA

BEST PLACE TO HAVE AN OIL WELL

GLOBAL NOTEBOOK

Service Pipe Line Installs Satellites	Page D-20
Computer Speeds Gas Accounting	Page D-26
Instrumentation – Efficient Money-Maker	Page C-4
Control Methods in Hydrocarbon Processing	Page C-7
Gas Engines or Electric Motors?	Page B-19
Air Drilling Pushes Abo Boom	Page B-82

Abrasijet . . .
a profitable way to complete a well

This cross-section illustration, as visualized by an engineer, shows a formation being notched with Abrasijet* — the Dowell-developed abrasive jetting service. The drawing was based on tests in which formation samples were notched with Abrasijet.

Notice the large surface area exposed by the notch. Notching with Abrasijet is an important starting point for recently-introduced frac design techniques. Abrasijet is also used for difficult perforating, vertical slotting of casing and cleaning open holes.

Results from hundreds of wells notched with Abrasijet and fractured by Dowell have been excellent, compared with similar wells fractured after perforating with explosives. Injection pressures required for fracturing have been lowered. Production increases have been outstanding. Gas/oil or water/oil ratios were improved. Occasionally, results from Abrasijet alone have been so good that fracturing was not required.

Ask your Dowell representative about Abrasijet. Dowell services and products are offered from more than 150 offices and stations in the United States, Canada, Venezuela, Argentina, Germany, France and the Sahara area. Dowell, Tulsa 1, Oklahoma.

*DOWELL SERVICE MARK

SERVICES FOR THE OIL INDUSTRY

DOWELL

DIVISION OF THE DOW CHEMICAL COMPANY

PETROLEUM Engineer for MANAGEMENT

NUMBER 4 • VOLUME 33 • APRIL, 1961

Australia — Best Place to Have an Oil Well . . . E-3

The nation's petroleum supply costs $300 million a year (the biggest import item) . . . More than half the land is under concession . . . great refining and petrochemical plants are expanding . . . You couldn't ask for a sounder market.
— J. M. Rayner

Australian Directories E-13

These include lists of oil operators, State and Territory Mines Departments, and supply and service companies.

How Good Is Your Guard? E-16

Those between you and the people who come to see you make your public image . . . Are your secretary, receptionist, PBX operator giving a good name? *— John Hinds*

Highlights and Footnotes A-2
Publisher's Page A-3
Advertisers' Index A-4
Course of Oil A-6
Petroleum Profile A-8
Samuel B. Mosher
Conference Table A-10
Management Personals A-20b
Laugh with Barney A-20c
Of Things to Come in Oil . . . B-3
Suppliers' Parade B-99
What's Doing in Drilling B-100
Drilling and Producing Literature B-102
Exploration Activities B-106
Drilling and Producing Equipment B-109
Running Tour with Man B-112
Construction Briefs C-3
Petro/Chem Equipment and Literature C-39
Petro/Chem Newsmakers . . . C-53
Construction Coming in Pipelining D-46
With the Pipeline Contractors D-52
News of Pipeline Suppliers . . D-57
News of Pipeliners D-58
Pipeline Equipment D-59
Pipeline Literature D-61

Don't miss the 14th Annual Report Survey next month. This indicates the health of the whole industry and is a good thermometer to use on your own company. Financial and operational data tell the story more accurately than any other one measurement. Look for the May issue.

Copyright 1961 The Petroleum Engineer Publishing Company

Indexed by Applied Science and Technology Index, The Engineering Index, Inc. and Chemical Abstracts

The Petroleum Engineer for Management, published monthly, August through June, semi-monthly in July by The Petroleum Engineer Publishing Company, 800 Davis Building, Dallas 2, Texas. Subscription rate to the petroleum industry, United States, Canada, and foreign, $4.00 per year; $7.00 for 2 years; $9.00 for 3 years; $1.00 for single copy. Entered as second-class mail matter May 1, 1932, at the post office in Dallas, Texas, under the act of March 3, 1879.

DRILLING AND PRODUCING

Gas Engines or Electric Motors B-19
— John M. Stevenson

242 Deep Wells Added in 1960 . . . . . B-26
— Ernestine Adams

Modern Well Completion Series, Part 11
Chemical Treatment for Well Stimulation B-34
— Francis N. Harris

What's New in Patents B-44
— Paul H. Johnson and James R. Head

Detect Sulfate Reducers and Evaluate Bactericides in Flood Water B-48
— Frank Yackovich

Waterflood Prediction Comparisons B-78

Air Drilling for Abo Pay B-82
— Clarence S. Adams

PETRO/CHEM ENGINEER

Instrumentation . . . An Efficient Money-Maker C-4
—R. E. Hughes

Instrumentation Trends in HPI C-7
— A. H. Schutte

SAMA . . . An Organization That Works for You C-9

Instrument Gadgeteering . . . Sound Practice or Waste of Time? C-12
— Charles R. Miller

Instrumentation . . . Too Much or Too Little? C-14
— Edward J. Byrne

Closed-Loop Chromatographic Control Optimizes Deethanizer Performance C-16
— David J. Froode

Control Trends in the Integration of Steam and Process Facilities C-22
— W. S. Bowers

Distillation . . . In View of Modern Developments, Part 2, Chapter 2e . . C-28
— Kenneth F. Gordon and James A. Davies

PIPELINE ENGINEER

Satellite Stations and Automation Solve Capacity Problem for Service . D-20
— V. L. Rupe

Computer Expedites Gas Accounting for NGPL D-26

Pipeline Fundamentals
Instrumentation, Controls, and Automation, Part 5: Telemetering . . D-29
— Max T. Nigh

Automatic Welding Without Pipe Rotation D-32

Measurement of Coating Leakage Conductance, Conclusion D-33
— Marshall E. Parker

Ideas at Work D-36

Pipeline Handbook Data Sheet
Manometer Factors for Hg Type Flow Meters D-37

highlights *and footnotes of the news*

John Kelly, New Mexico independent operator, was appointed to the post of Interior Assistant Secretary for Mineral Resources by President Kennedy. His province includes all mineral resources. A wildcatter and producer, Kelly has two degrees: one in mining engineering and one in petroleum engineering, both from New Mexico School of Mines.

Hydrocarbon Process Industry's relatively young petrochemicals division accounts for approximately 60% of sales of chemical and allied products in industry, and for well over 50% of investment in chemical plants and equipment. Petrochemicals production is expected to reach 56 billion lb this year, or 30% of all chemicals.

Coal industry leaders are said to prefer the Senate for the National Fuel Policy study and it looks as if they will get it. The Senate study committee would have 6 Democrats and 3 Republicans. Vice President Johnson would name the committee and choose the chairman.

FPC has limited use of escalation clauses in the natural gas contracts. The action would bar such contract provisions as "favored-nation" and "spiral" escalation clauses. In contracts filed after April 3 escalation clauses will be valid only if they set forth future price increases by specific amounts at definite future dates.

Western Oil and Gas Association plans to build a 5000-sq-ft exhibit building at Seattle's Century 21 Exposition. The exhibit will portray ways petrochemical products will affect life in the next century. Howard G. Vesper, president of the Association (also of Standard Oil of California) said the exhibit structure will be constructed adjacent to the $9-million Federal Science Pavilion sponsored by the U. S. Government.

Interests in some 23,000 acres of developed natural gas properties went to First Transportation Gas Company for a reported $27,000,000. Phillips Petroleum Company sold its interests in 67 wells, ranging from full ownership to 1/16 interest. Transwestern Pipeline Company will buy production from these properties.

Oil import regulations have been broadened: (1) newcomers will be allowed to enter importing field; (2) amounts allocated will depend on business done; (3) annual instead of quarterly allocations will be used.

Honolulu Oil has indicated Tidewater and Pan American will get the nod as purchasers. Properties will probably be divided on a geographical basis. In 1960 Honolulu produced 47,000 b/d oil; 3200 b/d LPG; 61 mmcf/d natural gas.

Hearings will resume March 15 before the California Public Utilities Commission on the application by California Gas Transmission Company to build and operate the 280-mile California section of the proposed Texas-Mexico-California pipeline project.

Tennessee Gas Transmission Co. has formed Tenneco Chemical Co. to construct and operate its new petrochemical complex on the Houston Ship Channel. Joe J. King, former vice president of Tennessee Gas, is president of Tenneco Chemical, and F. L. Padgitt, formerly director of project development, will serve as Tenneco vice president.

THE PETROLEUM ENGINEER PUBLISHING COMPANY

800 DAVIS BUILDING, DALLAS, TEXAS. CABLE ADDRESS: PEPUB

Ernestine Adams Management Editor
Frank H. Love Editor, Pipeline Engineer
J. C. Webb Editor, Petro/Chem Engineer
Lowell A. Murphy Asst. Ed. Drilling/Producing
Walter A. Hogan Field Editor
Lynn Patton Editorial Production Manager
Janis Page Editorial Assistant
Donald D. Fickert Presentation Editor

Allen K. Tyler Production Manager
Jack H. Selby Assistant Production Mgr.
Glen D. Hebert Advertiser Services Mgr.
Sherwood R. Entwistle Circulation Director
Royal Courtney Circulation Manager
Harold L. Seamans Circulation Field Service

Joe B. Woods President and Publisher
Abbott Sparks V.P. and Advertising Director
E. V. Perkins V.P. and Western Manager
J. E. Kastrop Editorial Director
L. H. Johnston Secretary-Treasurer
Roland D. Carpenter Controller

MEMBER OF
AUDIT BUREAU OF CIRCULATIONS
ASSOCIATED BUSINESS PUBLICATIONS

NEW YORK — **John L. McDonald**, **Lansing T. Dupree**
52 Vanderbilt Ave., MUrray Hill 6-7232
CHICAGO — **E. V. Perkins**, **H. G. Fitzpatrick**
53 West Jackson Blvd., HArrison 7-6883
LOS ANGELES — **Richard P. McKay**, **Bruce Berkey**
465 Converse Pl., Pasadena MUrray 1-0685
CLEVELAND — **Paul J. Mansfield**
Rm. 1510, Williamson Bldg., TOwer 1-4231
HOUSTON — **Jess Adkins**
2370 Rice Blvd., Room 110, JAckson 6-2631
DALLAS — **Ed Sealey**
800 Davis Building, Riverside 8-4403
BIRMINGHAM — **Fred W. Smith**
1201 Forest View, Vesthaven TRemont 1-5762
UNITED KINGDOM—**Kenneth S. Brooks**
10 Gilbert Place, London, W.C.I.
W. GERM. - HOLLAND—**Norbert Woelfl**
Lohernockenstrasse 18, Ennepetal-Voerde, Germany

Has Business 'Rights'?

When you set a new business down in this so-called capitalist system, it's like a baby in a playpen, it can move only a short distance before it hits the bars of federal, state and local taxes and regulations.

From that day on the simile is no good -- as the child grows, he leaves his pen and gains freedom. When a business grows, regulations increase, taxes become heavier, and red tape tightens. No wonder bankruptcies are on the rise.

Does business have any rights? Can business do anything but accept the almost impossible task of supporting an Atlas-size government, a military colossus, an international welfare fund, and at the same time pay most wage and salary earners and annuitants?

At the PESA meeting in Tulsa the president, Elliott Johnson (vice president, finance, and general counsel of Schlumberger) laid it right on the line:

"Our businesses do not have a guaranteed right to exist. They exist only so long and to such extent as government permits. Freedoms vanish when private industry vanishes. There are nations which do not tolerate private industry and there are other nations which have taken over certain segments of industry as ours has. Usually government confiscations are not achieved at one time or by one act. They are the culminating act of a series of political assaults over a period of years.

"For many years most businessmen have taken government for granted. Government has been looked upon as having an insignificant role subordinated completely to business as usual. In recent years there has been some awakening but because so little has been done for so many years, the tempo and concentration of effort on governmental affairs must be greatly accelerated.

"We may shout about government and politicians. That may salve some consciences but it remedies nothing. Personal action and effort are vital. In America, we still have the right and power to elect our leaders. People who want sound, stable government can achieve that result with the coordinated effort of all who love decency, honesty, and fair play.

"We must encourage qualified men to run for office; we must help elect qualified men; we must make our opinions known to elected officials; and we must compliment and encourage officials when they do a good job.

"If we businessmen continue to avoid our governmental responsibilities, we will ultimately find our business problems and headaches vanish as the government takes over. We can play an active role in political affairs and preserve our businesses with their problems OR we can continue to pass the buck, lose our businesses, and concentrate on politics to hold political jobs.

"You have a choice but not much time left to exercise it."

Thanks, Elliott. A lot of oil and gas people are concerned, but you convey the sense of urgency we must feel today.

Joe B. Hooks

Publisher

ADVERTISERS' INDEX

— A —

ACF Industries, Incorporated, W-K-M Division C-41, D-40, D-41
Ajax Iron Works B-61
American La France, a Division of Sterling Precision Corporation A-9
American Meter Company A-14
American Systems Incorporated D-61
Amot Controls Corporation E-16
Aqueness Department, Atlas Powder Company B-9
Arcco Instrument Company, Inc. D-49
Arno Adhesive Tapes, Inc. D-62

— B —

Baash-Ross Division of Joy Manufacturing Compnay B-98, B-99
The Babcock & Wilcox Company, Tubular Products Division C-21
Baker Oil Tools, Inc. B-18, B-38, B-39
Barber-Greene D-54, D-55
Baroid Division, National Lead Co. B-12, B-13, B-37
Bethlehem Steel Company D-14, D-15
Betz Laboratories, Inc. C-46, C-47
Black, Sivalls & Bryson, Inc. B-72, C-44
Boeing Airplane Company C-51
Brown Oil Tools, Inc. B-71

— C —

Cabot Corporation, Machinery Division B-1, B-7
Camco, Inc. B-4
Cameron Iron Works A-15
Caterpillar Tractor Company A-5
A. B. Chance Co. D-52
Charles Machine Works, Inc. D-58
Clark Bros. Co. B-62, B-63
Classified Advertising E-17
Collins Radio Company, Texas Division Sales D-9
The Colorado Fuel and Iron Corporation B-73
Conrad, Inc. E-16
Continental-Emsco Company, a Division The Youngstown Sheet and Tube Company B-43
Cooper-Bessemer Corporation A-20d
Core Laboratories, Inc. B-107
Crose-Perrault Equipment Corporation D-8
Crutcher-Rolfs-Cummings D-52

— D —

Dempster Brothers, Inc. A-16
Dowell Division of The Dow Chemical Company . Inside Front Cover, A-13, B-68, B-96
Dresser Electronics, SIE Division A-20f
Drilling Specialties Company B-89
E. I. Du Pont de Nemours & Co., Inc. C-19, C-20, C-37
Dynel, Inc. E-16

— E —

Equipment Engineers B-108

— F —

Fisher Research Laboratory, Inc. D-62
Fleetline Co. D-62
Fluid Packed Pump Co., Division of The National Supply Company B-104
Ford Motor Company, Allied Equipment Department D-17
The Foxboro Company D-38, D-39

— G —

Gardner-Denver Company B-65, B-66, B-67
Gar Wood Industries D-10, D-11
Gaso Pump & Burner Mfg. Co. A-20h
Geolograph Oil Field Service Co. B-105
Globe Oil Tools Co. B-108
The Goldak Company, Inc. D-60
Gray Tool Company B-88
Greenhead Inc. D-60
Groban Supply Company C-54
Grove Valve & Regulator Company, a Subsidiary of Walworth B-10, B-11
The Guiberson Corporation B-64

— H —

Halliburton Company ..... B-46, B-47, B-94, Back Cover
Harbison-Fischer Mfg. Co. B-101
Hercules Powder Company C-53
H & L Tooth Company D-53
H & M Pipe Beveling Machine Co. D-47
Houdry Process Corporation C-38
Hughes Tool Company B-74, B-75
Hughey & Phillips, Inc. D-62
Humble Oil & Refining Company C-43
Hycalog, Inc. B-97
Hydril Company B-35, D-35

— I —

Insley Manufacturing Corporation D-18

— J —

Johns-Manville Products B-92, D-19
Jones & Laughlin Steel Corporation D-44, D-45
Jones & Laughlin Supply Division B-14, B-15

— L —

Lane-Wells Company ..... Inside Back Cover
Layne & Bowler, Inc. A-20
Lenkurt Electric, Subsidiary of General Telephone & Electronics D-6, D-7
Link-Belt Company B-6
Lone Star Steel Company A-7
The Lufkin Rule Company A-11

— M —

Manzel, a Unit of Houdaille Industries, Inc. E-8
Magnet Cove Barium Corporation B-79
John N. Martin, Manufacturer B-105
Martin-Decker Corporation B-108
C. A. Mathey Machine Works, Inc. B-111, D-61
Maxim Evaporator Division, American Machine & Foundry Company B-103
The Mayo Hotel E-14
The Mercoid Corporation C-53
Mission Manufacturing Co. B-90
Montello, Inc. B-110
Mullins Mfg. Co. C-42, D-48

— Mc —

McCord Corporation D-59
McCullough Tool Company B-50

— N —

The National Supply Company, Subsidiary of Armco Steel Corporation B-51, B-52, B-53, B-54
National Tube Division of United States Steel D-50, D-51
Nicolet Industries, Inc. D-13
W. C. Norris, Manufacturer, Division of Dover Corporation B-59, B-112

— O —

Oil Center Tool Co. B-69
Otis Engineering Corporation B-83

— P —

Pacific Perforating Co., Inc. B-105
Panellit Division of ISI Incorporated C-50
Petreco, a Division of Petrolite Corporation C-40
Petroleum Electric Power Association A-18
Pittsburgh Steel Company B-80, B-81
Plicoflex, Inc. D-42
The Wm. Powell Company C-48
Procon Incorporated A-20a

— R —

The Rector Well Equipment Company B-77
Reed Roller Bit Company B-95
Restaurant Voisin E-18
Rockwell Manufacturing Co. A-20e, B-86
Roots-Connersville Blower D-12
Rust-Oleum Corporation A-19

— S —

Schlumberger Well Surveying Corporation B-85
Security Engineering Division B-60
Servco B-76
Shaffer Tool Works B-91
M. B. Skinner Co. C-52, D-59
A. O. Smith Corporation, Tubular Products Division D-4, D-5
Southern California Oil Tool Company C-53
Spang & Company B-109
Standard Oil Company (New Jersey) E-1
Steel Forgings, Inc. D-58
Stephens Engineering B-105
Stewart and Lloyds Limited C-49

— T —

The Tapecoat Company D-3
Teletype Corporation, Subsidiary of Western Electric Company, Inc. D-16
Thornhill-Craver Company B-8
Tretolite Division of Petrolite Corporation B-16
Trinity Portland Cement Division, General Portland Cement Company B-17

— U —

UGC Instruments, a Division of United Gas Corporation A-17
Union Wire Rope Corporation, Subsidiary of Armco Steel Corporation B-56, B-57
United States Instrument Corporation B-110, D-56
Universal Atlas Cement Company C-1
Universal Oil Products C-45, D-2

— V —

Valcor Engineering Corp. C-36
Valley Electric Company E-17
Van Products Co. C-54
Vermeer Manufacturing Company D-62
Visco Products Company, Inc. B-5
Henry Vogt Machine Co. C-2

— W —

Waukesha Motor Company B-41
Weksler Instruments Corporation C-51
Welex, Inc. B-2
Well Equipment Mfg. Corp. B-84
Well Equipment Mfg. Corp., Hamer Valve Division C-52
Western Supply Company C-39
Frank Wheatley Pumps & Valves E-15
Wheeling Machine Products Company E-17
The Wheland Company B-70
White Diesel Engine Division, The White Motor Company A-20h
Williams Brothers E-14
T. D. Williamson, Inc. D-43
Wilson Manufacturing Co., Inc. B-58
The Winston Company C-54
Wisconsin Motor Corporation B-102
W-K-M Division of ACF Industries, Incorporated C-41, D-40, D-41

— Y —

The Youngstown Sheet and Tube Company E-6, E-7

THIS INDEX IS PROVIDED AS AN ADDITIONAL SERVICE FOR OUR READERS — THE PUBLISHER ASSUMES NO RESPONSIBILITY FOR ERRORS OR OMISSIONS

"WE CAN MOVE MIGHTY CHEAP DIRT WITH A D7D"

HARVEY W. JONES, JONES CONSTRUCTION CO., NATCHEZ, MISS.

This is one of two Cat D7 Series D Tractors used by the Jones Construction Co. for site preparation and general construction work. Commenting on their ability to move cheap dirt, Mr. Jones said: "The D7D is the right size tractor for our oil field and other contracting work. It's large enough to do the job—and small enough to be easily transported. We're well pleased with the trouble-free operation the past year. A D7D can't be beat!"

How about you—are you moving dirt as cheaply as you can? An older model tractor that is paid for may seem to move dirt at low cost. But in reality it could be losing as much as it earns. It just can't move earth as cheaply as a new machine. Why?

The D7D, for example, is more powerful and easier to maintain than predecessor models. Its ability to do more work and do it for less cost could greatly increase your profit potential. You can check this by comparing the production and costs of your present equipment with the D7D. For the full story and a demonstration with measurable results, see your Caterpillar Dealer. He has some eye-opening facts. He'll lay them on the line for you!

Caterpillar Tractor Co., General Offices, Peoria, Ill., U.S.A.

CATERPILLAR

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

INCREASE YOUR EARNINGS WITH A D7D

D7D MONEY-EARNING FEATURES

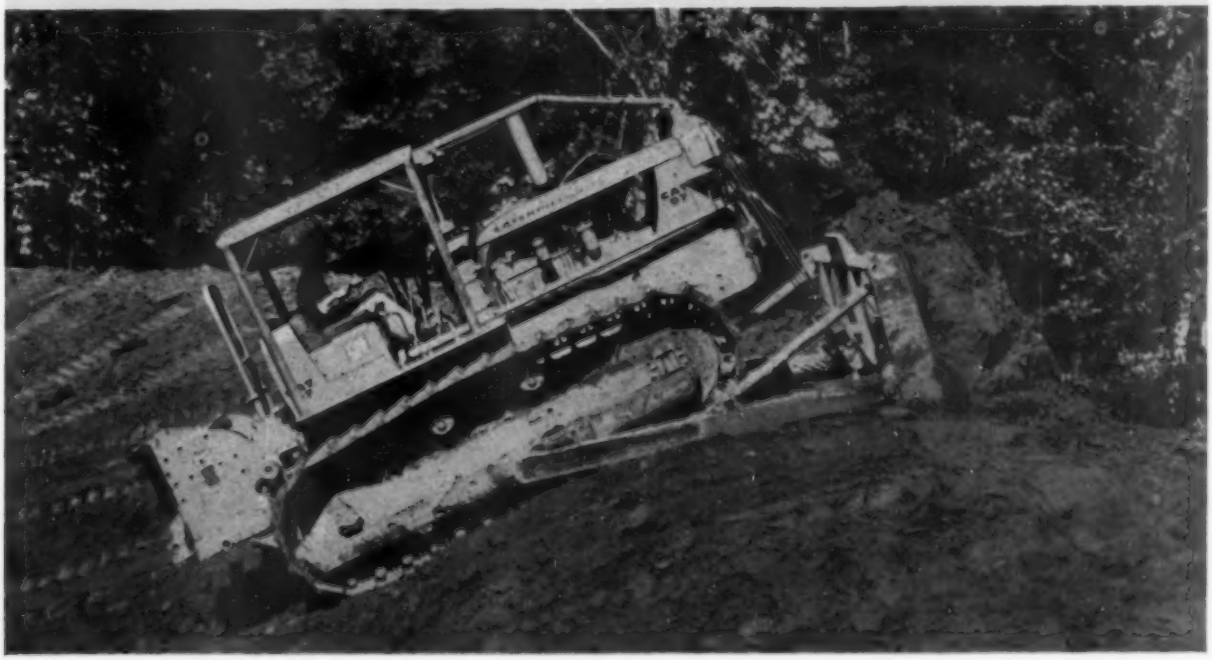
TURBOCHARGER—offered only on the D7D in its class. Addition of this unit has boosted HP to 140 at the flywheel, almost doubles lugging ability, delivers more efficient combustion for important fuel savings.

DRY-TYPE AIR CLEANER—removes at least 99.8% of dirt from engine intake air under all conditions. Materially lengthens engine life by protecting it from abrasive dust. Can be serviced in five minutes.

POWER TRAIN—stronger and better than ever, with final drive gear teeth strengthened 50%. Another factor increasing drive train life: an improved lubrication system for transmission, bevel gear and pinion.

ROLLERS—no more costly down time from improper or missed lubrication. Exclusive floating ring seals keep constant pressure on seal surfaces—oil stays in, dirt out. These rollers never need attention until rebuild time.

OIL CLUTCH—another exclusive in the D7D class. Users report up to 2000 hours of adjustment-free service on even the most severe applications. Clutch replacement almost unheard of!



Course of Oil

patterns for prosperity

OUR ANALYZERS SPEND great study on the causes and trends of recessions, depressions, downturns, upturns. What we'd like to see are some patterns for progress.

Oh, you're getting glib answers for economic expansion from politicians and labor union leaders. But business management and business analyzers — the ones who tell us what the situation is, the ones who must either make plans for progress and execute them or turn the job over to the state — aren't talking.

Radical economists have solutions to everything — all centered in collecting $100 billion tax money in Washington and working it out from there. Practical economists, who have read their histories and know how many times this primrose path has been followed to chasm and chaos, object. But our quest is not answered. What we want to know are the patterns for advancing private enterprise in times of national economic doldrums.

Labor leaders call for more unemployment benefits. That's a sedative. Politicians call for tax-paid medicine — that may be a vote-breeder but it's a drug, too. It deadens our responsibility as individuals to our parents and to ourselves.

We don't need a Miltown — we need a pep pill. Where are we going to get it? Business and industry say taxes and government controls are so limiting that the only way to stay in the black is by tightening up. Some management looks hopefully to government aid. Says an economics writer: "Much of the optimism in business circles as well as in the stock market is based on expectations of what Washington will do."

Is there a pattern for practical, down-to-earth prosperity outside of government leadership? Can business and industry create their own force of progress that works when the cycle is down as well as when it is up? Can they protect economic freedom from the political erosions that stay to plague them in good times?

It can be done. It will take rare courage and high risk but it will be worthy of the valiance it demands. There are a few markers that point the way to stronger leadership of business management — and it must lead if our battered free enterprise is to survive.

Some of you can remember when it was illegal for a company to contribute to education. Jersey Standard fought that battle through the courts and now firms contribute millions to education. So don't recoil when we suggest contributions to other enterprises. Every kind of business growth helps the petroleum industry. Why shouldn't it be sponsored, as Junior Achievement is sponsored, on a senior level?

Another promising pattern is the work of annuitants in counselling new business. Why not a small fund to help retired executives in promoting young enterprises? Or retired workers to start new ones? Why not assign an individual or committee to work on prosperity patterns?

The excitement and creative impulses that swarm with growth and new projects are too precious to lose. They can make business and industry a sparkling force — not a reaction to events or political maneuvers.

Every sane American says — Don't put us to sleep with a political stop-gap sedative. Nor a labor union program of spurious security. Give us a pattern for real progress!

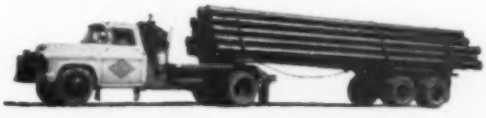
Business and industry, the spot is yours — all yours.

— Ernestine Adams

Congrats and $25 for this quip to CAROLYN KENEDY, Bells Wells Oil Company, Box 269, Miami, Oklahoma.

When it comes to shapeliness . . . Lone Star pipe proportions are right! All dimensions and qualities are strictly API specifications.

Lone Star Steel . . . America's most modern pipe plant . . . is Joe Roughneck's solid source of supply. Right here in the center of the oil country . . . quick availability of Lone Star pipe is a terrific convenience.



Neighbor, wherever you are, specify Lone Star and we both get a good deal.

Lone Star STEEL COMPANY

© 1956 Lone Star Steel Company

EXECUTIVE—SALES OFFICES
W. Mockingbird Lane at Roper • P. O. Box 12226 • Dallas, Texas
DISTRICT SALES OFFICES
912 Republic National Bank Building, Dallas, Texas
Houston, Texas | Midland, Texas | Tulsa, Oklahoma

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

petroleum profile

IN HIS MANY INTERESTS and business ventures, from breeding rare orchids to heading the West's largest independent oil company, Samuel B. Mosher has the golden touch. The genial chairman of the board and chief executive officer of Signal Oil and Gas Company has a reputation for success — both in and out of the petroleum industry. As friends say, "Who else but Sam Mosher could turn a hobby into the largest orchid-growing business in the world?"

It hasn't always been lush for Sam Mosher, though. After graduating from the University of California in 1916 with a degree in agriculture, he started farming near Los Angeles. Agrarian life didn't prove profitable for young Mosher, and five years later he decided to look for a more rewarding business.

He and a college friend became interested in building a small plant for the production of casinghead gasoline, an operation about which they knew little. In addition, they had no capital. But in 1922, armed with a technical brochure from the Bureau of Mines and a $4000 loan, they founded Signal Gasoline Company (later renamed Signal Oil and Gas Company) and began producing casinghead at famous Signal Hill. The tiny operation prospered and grew with the field, and within a few years the company had seven gasoline plants at Signal Hill and Huntington Beach. In the meantime, Mosher had bought his partner's interest in the business.

SAMUEL B. MOSHER
Chairman of the Board
Signal Oil and Gas Company

Signal's success — closely tied to that of Mosher — enabled the budding oil tycoon to enter the crude oil production phase of the industry in 1928, when he took over a partially completed wildcat in California's San Joaquin Valley. He hit oil in his first venture. Subsequently Signal acquired additional properties in other areas of California, and eventually grew to be the biggest independent producer of crude oil in the state.

In 1931, Signal became a marketer of refined products by buying a chain of 700 California service stations. This operation was expanded and aggressively promoted, and by 1933 stretched from Mexico to Canada on the West Coast. The entire chain and the Signal brand name were sold to Standard Oil Company of California in 1947. Since that time, Signal Oil and Gas Company has not marketed refined products under the Signal brand. Signal was back in retail marketing in 1954, when the company bought controlling interest in the West's high-volume Regal stations.

Mosher was not content to remain a domestic producer, so he made deals for the exploration and development of foreign oil. As owner of 30% of American Independent Oil Company and a participant in the Iranian Oil Consortium, Signal gets a considerable amount of crude from the Middle East. In addition, Mosher's company is operator and half-owner of a large concession in Lake Maracaibo, Venezuela, and has important interests in several other Latin American countries and Canada.

A natural corporation marriage was consumated in 1958 when Signal merged with Hancock Oil Company, which was another pioneer California oil firm. The two companies' backgrounds and operations were unusually similar, and they had been partners in many joint operations. This development expanded significantly Signal's marketing operations, to which was added the Hancock brand.

Signal became a still more fully integrated company in 1959 by merging with Bankline Oil Company, which owned a refinery in Bakersfield, California. Another marketing brand, Norwalk, was picked up as a result of the Bankline merger.

Signal also merged with Eastern States Petroleum & Chemical Corporation in 1959, adding refining, petrochemical, and marketing facilities.

Mosher's keen business eye has not been trained on the oil business alone. Along the way Signal has acquired almost one-half interest in American President Lines, Ltd. (one of the world's largest shipping organizations). The company is also sole owner of Scudder Food Products, Inc., a large producer of potato chips, mayonnaise, peanut butter, and other food lines. In addition to controlling the majority of Signal's voting stock, Mosher is chairman of the board and major stockholder of Flying Tiger Lines, Inc. These and his many other widely diversified interests make him one of the wealthiest men in the country.

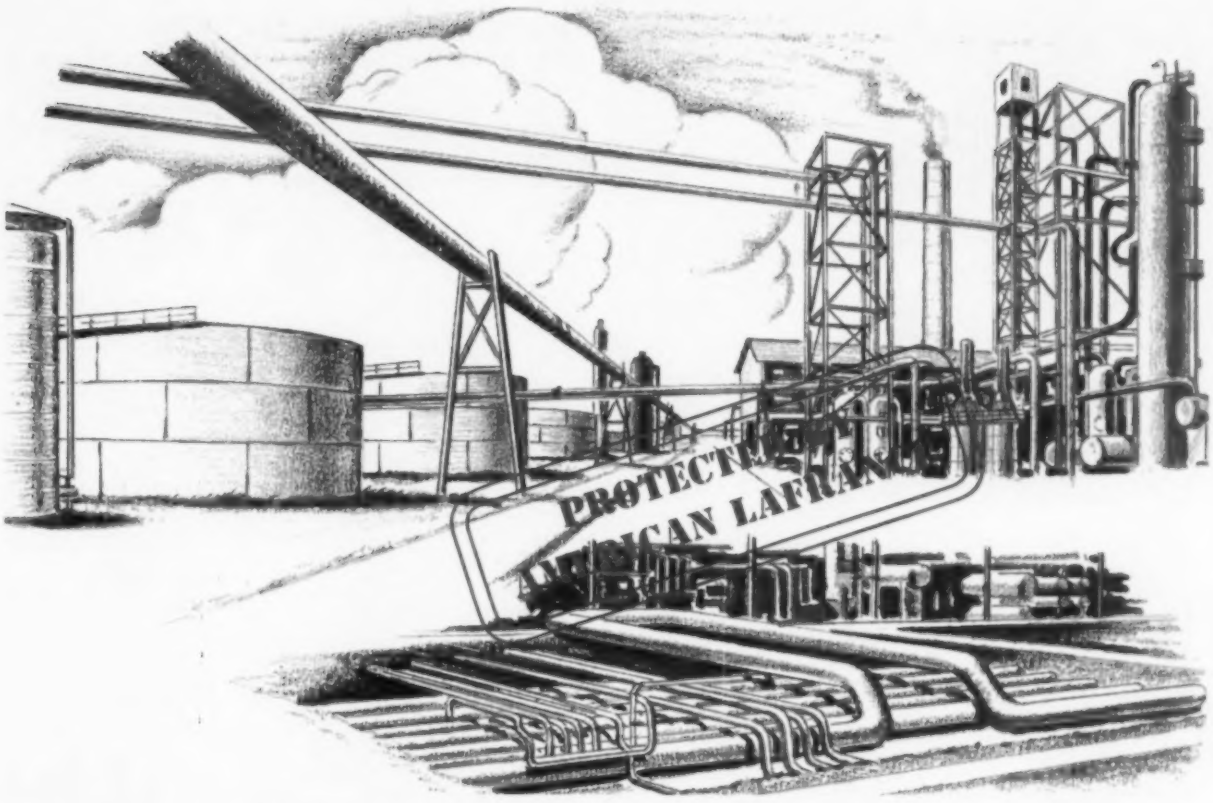
Born in Carthage, New York, Mosher has lived in California since early childhood. He likes to hunt, and enjoys staying at his beautiful, historic 5000-acre Dos Pueblos ranch near Santa Barbara, where his orchid operation is located. Dos Pueblos was acquired in 1943 as an oil property, and as such was not a disappointment to Mosher: 40 wells have been completed successfully there. Furthermore, the lovely site is a working cattle ranch, a game reserve, and is entirely self-sufficient agriculturally.

He is married to the former Leedja C. Orloff, and has a daughter, Mrs. Arthur P. Williams, and four grandchildren.

In spite of his numerous interests and activities, Mosher spends considerable time working as a regent of the University of California and a trustee of Occidental College. He is a director of the American Petroleum Institute, and during World War II was a director of the Petroleum Industry War Council.

Not long ago someone observed to Mosher that nowadays it's almost impossible for a businessman to begin from scratch and become a great success.

"It's funny," Mosher replied, "but that's exactly what they were telling me when I was getting started."



FIRE PROTECTION *"Custom Engineered"*
to meet your *specific plant* requirements

Whether your plant is large or small, your fire protection program must be correctly designed and engineered to guard against loss by fire. American LaFrance has long been identified as the *"Trusted"* name in positive fire protection service. Long experience and specialized engineering know-how have developed an incomparable advantage in quality equipment and broad application knowledge in the fire protection field.

American LaFrance products cover the entire range of fire protection equipment from small fire extinguishers through complete chemical systems of all types. Regardless of the hazard, you can be sure of sound recommendations providing maximum security from the hazards of fire.

● *Sales Offices and Representatives in all major cities.*

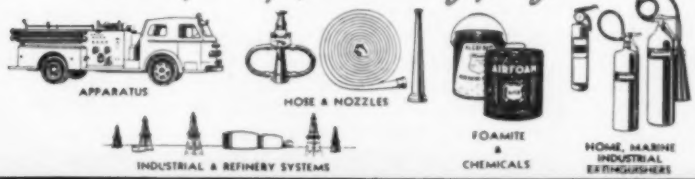
Put this ability and knowledge to work for you. Let American LaFrance show you the way to engineered fire protection in your plant.

Call, wire or write your nearest American LaFrance Representative or 55 E. LaFrance St., Elmira, N. Y., for a survey of your plant. No obligation, of course.

"TRUSTED" FIRE PROTECTION

Dry Chemical, Carbon Dioxide, Foam, Water, Soda-Acid Extinguishers . . . Wheeled Engines . . . Carbon Dioxide and Foam Systems . . . Industrial Fire Apparatus and Supplies. Send for free booklet "First Minute Fire Control" illustrating this equipment.

Everything you need to fight fire!



AMERICAN LA FRANCE

A DIVISION OF STERLING PRECISION CORPORATION

ELMIRA, N.Y.

LaFrance Export Corporation
Elmira, N.Y.
LaFrance Fire Engine and Foamite, Ltd.
Toronto 18, Ontario, Canada

The World's First and Largest Makers of Fire Fighting Equipment

the conference table

Despite Problems Oil Industry Looks Ahead

An appraisal of the petroleum industry by Francis I. du Pont & Company, the investment firm, in the latest issue of its *Investornews*, says the domestic oil industry is inherently sound despite its problems. Virtually all the companies are in good financial condition with very low ratio of bonds or other indebtedness to their total assets. The study goes into all the disadvantages, such as excess capacity of crude oil production, competition from natural gas, electric power and coal, Russian exports into Western Europe, and increased Soviet production.

The appraisal concludes, however, that the advantages offset drawbacks. Some are the expansion in petrochemicals, the rising demands for oil products abroad, and the long experience of U. S. companies in foreign operations.

"Those who cannot remember the past are condemned to relive it." — George Santayana.

Getting Ready for Foreign Tour

Foreign countries are said to be getting wrong impressions of the United States because many Americans working abroad don't trouble themselves to learn the customs or language of the country in which they are working. With this problem in mind, The Ohio Company is experimenting with a program to train selected employees in the customs and language of areas where they might someday be assigned.

Dr. Evans E. Gazala, staff assistant to the Ohio Oil manager of corporate funds division, volunteered to develop the experimental program to train a limited number of employees in the Arabic language and customs. The company has operations in North Africa where the training would be useful. Dr. Gazala studied in Baghdad, Iraq, and at the American University of Beirut, Lebanon.

Pictured in the photo is Dr. Gazala at the opening session of Ohio Oil's course. After six one-hour sessions, the 10 men in the class were able to speak some Arabic.

More Secretaries for Science Sake

In the research race with Russia, one good secretary is worth at least two good scientists, a Canadian expert writes in the Worm Runner's Digest, informal journal of The University of Michigan Department of Psychology's Planaria Research Group.

Robert Sommer observes: "It is axiomatic that a lab can produce only as fast as its secretary can type. The lab with one scientist and four secretaries is in a more favorable position than the lab with four scientists and one secretary.

"In the latter case, the scientist will spend most of his day peering over the secretary's shoulder seeing whether she is showing favoritism to his three colleagues. There will be intrigues and quarrels to get letters typed, income tax forms filled out, and lead pencils requisitioned. Realistically there is no motivation for the scientist to write if there is no one to type for him.

"In the lab with one scientist and four secretaries our man is in constant turmoil to keep his assistants busy. He feels he must produce so that his harem looks busy. If they start bringing in knitting and learning bridge, his superiors will become suspicious."

Sommer formulates the following "law" for the scientific output of any research laboratory:

$$\text{Productivity} = \frac{\text{Number of secretaries} \times \text{average typing speed}}{\textit{Number of scientists}}$$

"One interesting feature of this equation," he notes, "is that when the number of scientists becomes zero, productivity becomes infinite.

"This is probably true, but has never been tested empirically."

Oaks are the true conservatives; they hold old leaves till summer gives a green exchange. — Roy Helton.

We've Told You Before

The Flexsteel Newsreel puts its prophesy for 1961 into some sure-shot forecasts. It predicts:

Business will continue to go where invited and remain where appreciated.

Reputations will continue to be made by many acts, and be lost by one.

People will go right on preferring to do business with friends.

Go-givers will become the best go-getters.

The "extra-mile" will have no traffic jam.

Performance will continue to outsell promises.

Enthusiasms will be as contagious as ever.

Know-how will surpass guess-how.

Trust, not tricks, will keep customers loyal.

Quality will be prized as a precious possession.

New Motor Oil For Boats

Esso claims a remedy for one of the most common boating problems, with development of a new outboard motor oil designed for use with regular grade leaded gasolines.

The problem is spark-plug fouling in high-performance two-cycle engines. They range from about 35 to 80 hp. These outboards use a mixture of oil and gasoline for fuel as do many power lawn mowers.

Spark-plug fouling causes expensive engine cleaning and frequent plug replacement. In most cases, according to Esso, its new oil reduces such failures by at least 80% compared to conventional outboard motor oils.

Exclusive LUFKIN Chrome Clad® lines defy grit, grease, gravel—and rugged use!

Here are "he-man tapes" that work like troopers when the job's toughest!

Easy-to-read markings will *stay* easy to read, because they're bonded to steel, electroplated and chrome coated. Lines won't kink or break. Sturdy metal construction (except for carrying handle). It all adds up to two-fisted quality that *lasts!*

Exclusive quality features are yours in *all* Lufkin tapes. For example:

Lufkin Chrome Clad® DERRICK Tape (above, left) gives you instant readings on a line that won't rust, chip or peel. An extra-sturdy line, ¼" wide, with hook and ring. Lock-handle frame. Turn handle over, lock line at any point. Available in 100-200' lengths.

Lufkin "ATLAS" Gaging Tape (above, right) gives you easier reading, too, with durable, jet-black markings on glare-free line. Line is 50% heavier than standard. Has 20-ounce plumb bob, and sturdy lock-handle frame.

See your Oil Supply House.

Measure for measure, the finest made...

LUFKIN

SAGINAW, MICHIGAN

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Relation of One Part to the Whole

A letter from Virgil L. Barr, executive assistant to the chief, Division of Petroleum, Bureau of Mines, writes us of his interest in our editorial in the February issue called "danger: dubious guideposts." Mr. Barr makes a definite contribution to the development of measurement standards in a paper presented to AIME.

His contention is that one of the problems for public relations for the petroleum industry is that we have no standards by which to compare our industry to the economy as a whole. He feels that this would present a better picture to the public of the industry. Our industrial management would be more confident if it could measure its performance with some standard that reflects all management decisions and our technologists would be interested in how well they are doing and what they must do in the future.

Mr. Barr has carefully worked out in tables his own method of measurement for his argument. His conclusion is that the petroleum industry has kept pace with total industry; that its ability to continue depends on the technological improvement from research and development.

If you wish to preserve your secret, wrap it up in frankness. — Alexander Smith.

Why Use Coal as Economic Measure?

In the February "Course of Oil" (Dubious Guideposts) we were complaining about measurements we felt to be unstable. One evidence of this shows up in the 1960 Supplement to Economic Indicators, prepared for the Joint Economic Committee by the Committee Staff and the Office of Statistical Standards, Bureau of the Budget.

In this weekly indicators of production include such things as steel produced, electric power distributed, bituminous coal mined, freight loaded, paperboard produced, and cars and trucks assembled. No mention of oil and gas. Isn't this slightly on the ridiculous side when you consider that coal is in the minority as an energy fuel? The government publication explains:

"Although bituminous coal is still an important industrial fuel, its importance has decreased in recent years. In 1920 it accounted for 67.4% of the total supply of energy from mineral fuels. In 1940, for 47.2%, and in 1959, for 22.4%."

Regardless of whether it's minor or not, it is still one of the government's weekly indicators of production of the United States and assumes great importance in evaluating the economy. Oil and gas are not considered economic indicators in this weekly series. If you thought petroleum energy was vital to our economy, here is one place your opinion is ignored.

An economy runs best when least encumbered by economic theory.

The Supreme Court Dictates

The U. S. Supreme Court on January 23 held that the Federal Power Commission has the authority to control the "end use" of natural gas. If we could be philosophical about it we would say that this is just one more time when the Court wandered all over the barnyard instead of using law.

In this case, the FPC had denied the right of Consolidated Edison Company of New York to purchase gas in Texas and have it transported by Transco to its plants in New York to be used instead of coal or oil.

Minor S. Jameson, Jr., executive vice president of IPAA, said that in its decision the Supreme Court in effect has ruled:

1. Conservation requires that natural gas be "saved" by denying its use to classes of consumers.
2. The Federal Government, therefore, through the Federal Power Commission, has the authority to control the "end use" of gas, forcing consumers to use a less desirable fuel — coal.
3. The function of the Federal Government is to ration gas supplies by controlling both prices and end uses, with little or no regard as to whether adequate gas will be found and developed to meet future demands of the consuming public.
4. Every aspect of gas production, transportation and sale should be regulated; with the Federal Government having the authority to control all aspects not under state regulations.

Rents Out Oil Wells

YPF, the Argentine State oil agency, has signed a contract with a private firm allowing the company to operate certain YPF oil wells and use the petroleum produced for its own consumption.

The company, Grassi S. A., built a smelter in San Martin which uses its own thermal generator and oil from the YPF wells will fire this thermal unit. YPF will rent Grassi all equipment necessary to operate the wells, and in addition to the rental YPF will receive a royalty from the oil produced. The wells, producing about 9500 bbl a month, are in the Pampa Palauco field in Mendoza.

"Paper money enables government to expropriate the citizen legally by inflation or repudiation." — Peter F. Drucker

Never-Never Land

Mr. B. K. Nehru, India's Commissioner General for Economic Affairs, told the U. N. Economic Committee that all industrialized countries of the world should provide $7 billion in funds for development of underdeveloped countries. Also, he said, this money should represent net outgo and not gross.

Mr. Nehru was kind enough to say that the bilateral assistance of the United States was important, not only because of its magnitude but because it was provided on terms which did not throw an appreciable burden on balance of payment.

We're glad somebody appreciates our assistance, but we'd like to point to where it has got us. It got us a burden of balance of payment.

Oasis In The Far East

The importance of Australia in international business and industry has always been recognized and, in recent years, its growth has placed it in a still more attractive light. Last month American Management Association held a briefing session in New York on opportunities for American investment and industry in Australia.

You may be as surprised as we were to find out the number of companies interested in Australian concessions. On page E-4 is a list of concessionaires which is not all inclusive, many of the companies are combinations of two or more firms. With the work and determination of exploration branch of the industry, it will surely not be long before Australia operations get a breakthrough in production. The continent is already a large center of refining and petrochemicals.

Good Wells Make Good News

A Report on Interesting Acidizing Treatments by Dowell

April, 1961

These four recent examples demonstrate a few of the many well conditions that respond to Dowell acidizing.

- **Alberta, Canada** (New Gas Well) When a drill stem test yielded 4 mmcfd, operator decided to complete this wildcat. Pay is the Mississippian lime between 6971 and 7013 feet. Porosity is 5.1 per cent. Solubility is 95.5 per cent. Average permeability of the interval is one millidarcy. There are short, more permeable sections at two levels within this interval. These permeable sections were perforated, washed with BDA* Breakdown Acid and acidized. 30,000 gallons of a special Retarded Acid, with a fluid loss additive, were injected using three Allison-powered pumpers. The Acid Guide* was used to plan this treatment. Production test before treatment was 100 mcfd. After treatment well tested 14.2 mmcfd at 1900 psi on ½-inch choke. (Calculated open flow was 35 mmcfd.)

- **Tom Green County, West Texas** (Abandoned Oil Well) This well in the Mertzon-San Angelo pool had originally been perforated and acidized. It was abandoned temporarily after producing only 3 barrels of oil and eight barrels of water per day. Recently, Dowell was called to help recomplete the well. First, the old perforations from 1550 to 1565 feet were squeezed off using 125 sacks of cement modified with FLAC* fluid loss additive for cement. Next, three holes were jetted at 1558 feet with Abrasijet* -- Dowell's abrasive jetting service. Then the well was acidized with 500 gallons regular acid. After clean-up, well tested 100 bopd; no water.

- **Texas County, Oklahoma** (New Gas Well) A lower section of the Topeka lime (3182 to 3198 feet) tested 3 mmcfd after being perforated and acidized. A plug was set above this section and an upper zone was then perforated from 3090 to 3160 feet. When it also tested 3 mmcfd, communication was suspected. Dowell suggested selective acidizing using rock salt as a temporary plugging material. The upper section was acidized with 15,000 gallons Dowell acid containing demulsifier, surfactant and a silicate control agent. 4000 pounds of rock salt were used in three stages during treatment to block communication with the lower zone and to divert acid into the less permeable sections of the upper zone. After well was swabbed and cleaned up, it tested 14.5 mmcfd from the two zones combined.

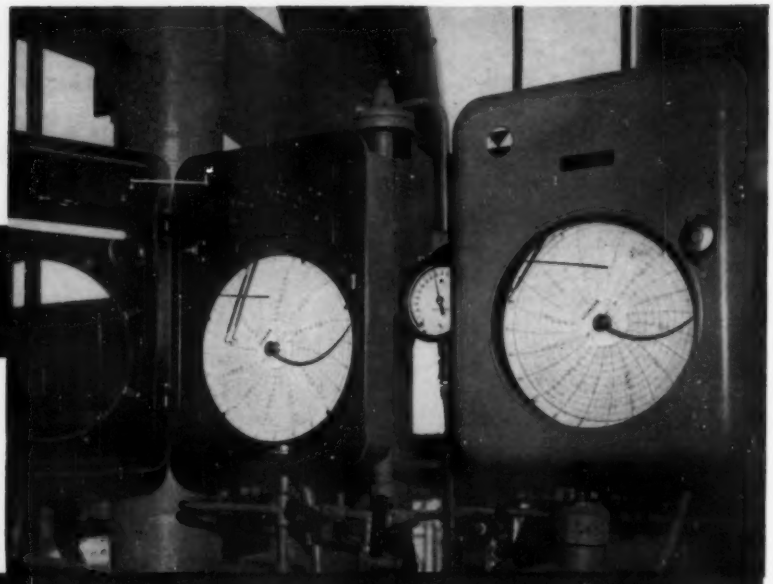
- **Lafourche Parish, South Louisiana** (Old Oil Well) This well in the Miocene was mudded off during workover and would not come in despite good porosity and permeability. Dowell acidized with 500 gallons Mud Acid injected between 250-gallon slugs of regular acid containing a demulsifier and an agent to lower surface tension. Injection rate was one bpm at 1700 psi. After acid was swabbed out, well made 115 bopd allowable.

Dowell services and products are offered from more than 150 offices and stations in the United States, Canada, Venezuela, Argentina, Germany, France and the Sahara area. Dowell, Tulsa 1, Oklahoma.

*DOWELL TRADEMARK

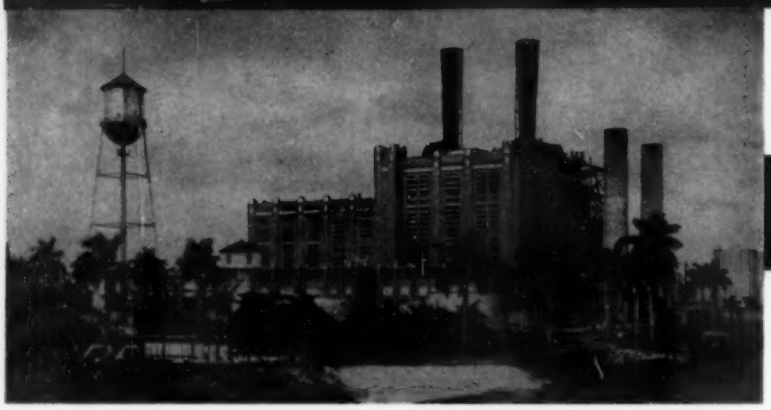
Services for the oil industry DOWELL

DIVISION OF THE DOW CHEMICAL COMPANY



American Integrating Orifice Meters, in a duplex setting, measure gas for boiler at Ft. Lauderdale power plant. These meters are equipped with a fixed gear train to provide a direct reading in cubic feet of gas at base conditions.

AMERICAN® instrumentation solves measurement problem for Florida Power and Light Co.



Florida Power and Light's Ft. Lauderdale power plant. Two of five boilers use 45 million cubic feet of gas per day on an interruptible basis, can consume up to 60 million cubic feet daily.

In each of the eight Florida Power and Light Co. power plants throughout the state, several boilers are fueled by natural gas. Florida Power and Light required a meter that provided a direct reading in actual cubic feet of gas used by each boiler. Measurements would then be transmitted by Telemetering to central data-gathering offices.

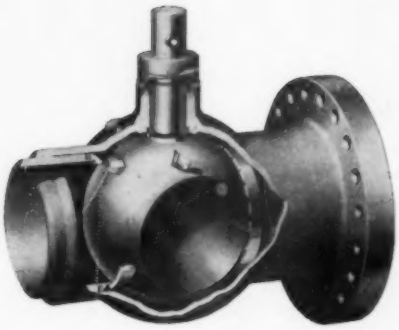
American Meter Company supplied a modified Integrating Orifice Meter with a counter reading in cubic feet of gas at standard base conditions that solved their unique measurement problem.

Whether your requirements are simple or complex, you can rely upon American Meter's 125 years of engineering experience to give you the dependable equipment you need for years of accurate, trouble-free measurement and control.

AMERICAN METER COMPANY

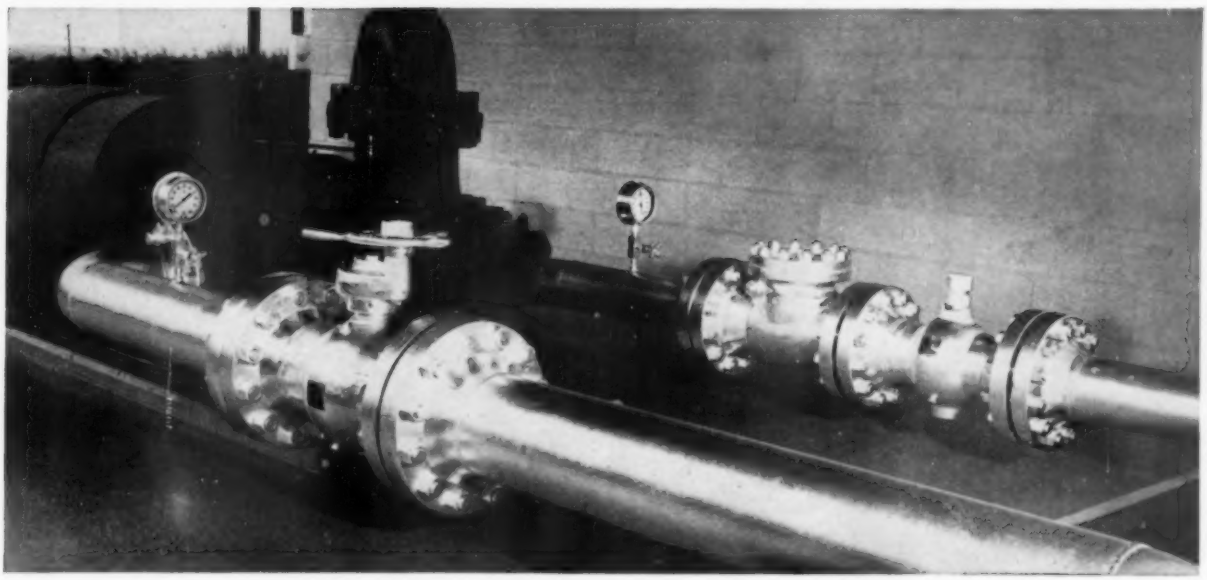
GENERAL SALES OFFICE: Philadelphia 16, Penna. • Albany Atlanta • Baltimore • Birmingham • Boston • Chicago Dallas • Denver • Houston • Kansas City • Los Angeles Minneapolis • New York • Omaha • Pittsburgh San Francisco • Seattle • Tulsa • Wynnewood IN CANADA: Canadian Meter Company, Ltd., Milton, Ontario • Calgary • Edmonton • Montreal • Regina Vancouver

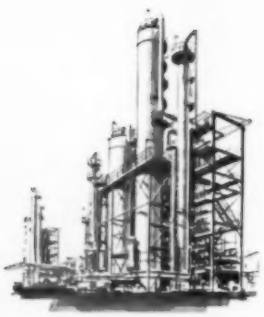
SAY GOODBYE TO VALVE REPAIR



That's right – with Cameron Ball Valves on the job you never need to make repairs. This big step forward in valve design – which makes practical the "sealed for life" construction – is brought about by the exclusive rotating seat principle which has proven so successful in our Type "F" Gate Valves.

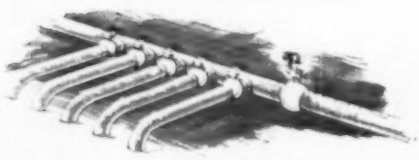
Sturdy dogs on the Ball engage gear-like teeth on the Seat Rings to rotate the Seats a fraction of a turn each time the valve is opened. In all valves, maximum wear occurs on the seating surface area which is struck by the erosive blast of line fluid just as the port is uncovered on opening, or just as the flow is being pinched off on closing.





Rotation of the seats distributes this wear equally over the entire sealing surface and extends the life of the valve many times over valves with stationary sealing surfaces.

Also, being non-lubricated, all maintenance costs are eliminated. This means substantial savings in man hours, down time and inventories. Low torque requirements allow smaller operators – less energy on remote controls – easier operation an manual controls. Maximum economy – Maximum service – Mimimum size and weight. Available in sizes 2" to 36" in ASA and API ratings and with any type of end preparation. If you plan, specify or purchase valves, call or write Cameron for complete details.



Cameron

CAMERON IRON WORKS, INC. • P. O. BOX 1212 • HOUSTON, TEXAS

For Materials Handling or Refuse Collection

DINOSAUR + DINOMASTER

Handles (in addition to DINOMASTER) containers eight through 40 cu. yd. capacity and over

When mounted on DINOSAUR, provides "No-Container-Haul" Service for refuse containers, one through eight cu. yds.

Besides serving DINOMASTER, the DINOSAUR picks up huge loads in big capacity containers . . .

DINOSAUR picks up DINOMASTER hydraulically for refuse container service.

extremely heavy materials in smaller containers . . .

DINOMASTER engages loaded container and lifts it into emptying position.

. . . and can even handle two containers at a time for additional flexibility.

Contents fall into body where up to 85,000 lb.* pressure packer plate compresses material to a fraction of its former volume.

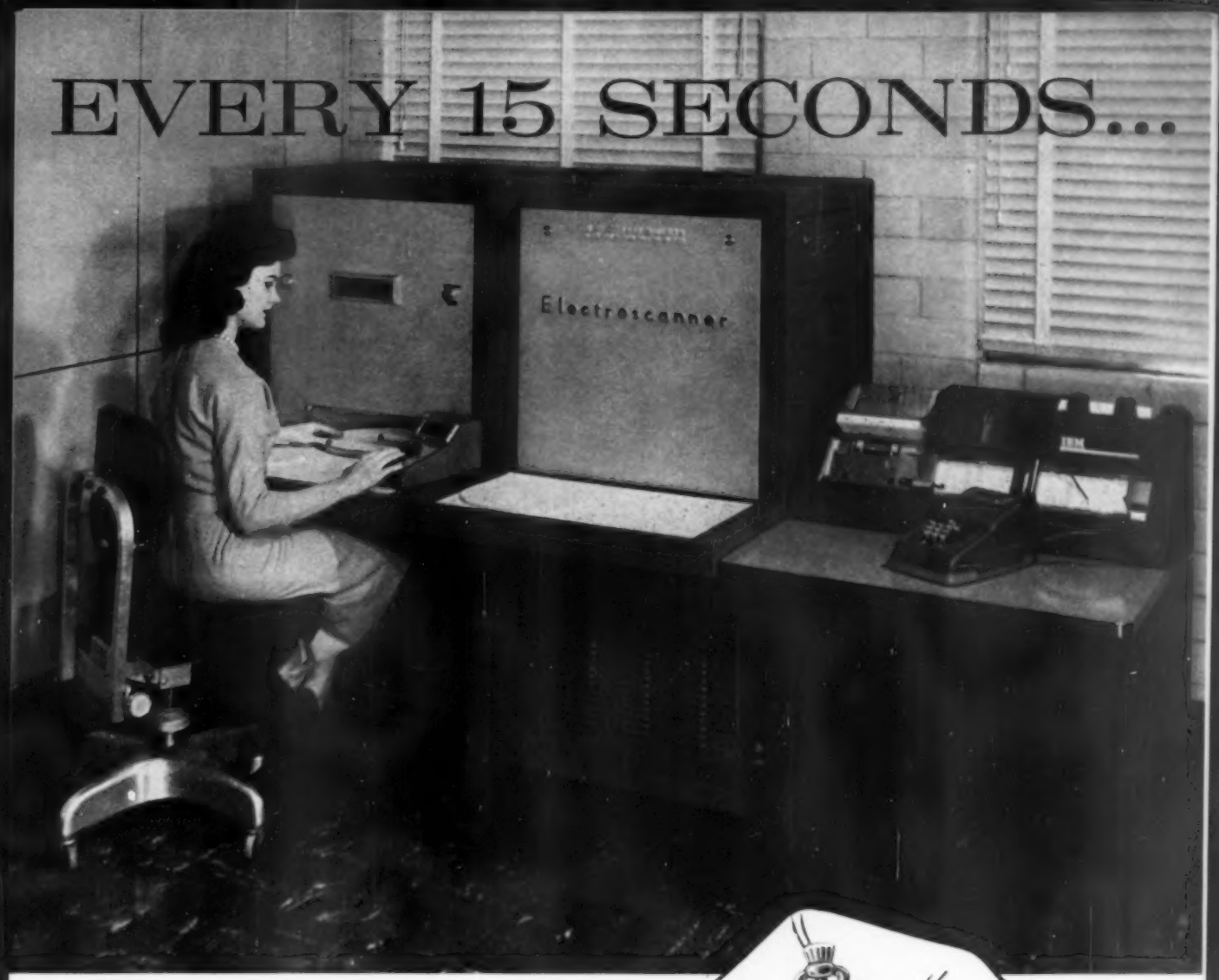
*On 30 yd. Model

PART OF THE DEMPSTER DUMPSTER® SYSTEMS

Mfd. Only By
DEMPSTER BROTHERS
Inc.
Dept. PE4, KNOXVILLE 17, TENNESSEE

WRITE TODAY FOR COMPLETE INFORMATION

EVERY 15 SECONDS...



...AN ORIFICE METER CHART is scanned, computed, printed and a card punched with a UGC Instruments

ELECTROSCANNER

In one 8-hour day approximately 2000 flow charts can be processed by an unskilled operator. To manually integrate the same charts would require twelve integraters and twelve highly skilled operators. No figuring, judging, printing or manual skill is required. Efficiency is increased while operational costs are greatly decreased — and no personnel problems are involved! The Electroscanner is another UGC Instruments major innovation in the automation of chart processing.

UGC
A DIVISION OF UNITED GAS CORP.
INSTRUMENTS
ELECTROSCANNER

For Further Information Phone or Write:

UGC INSTRUMENTS
P. O. Box 1407
Shreveport, Louisiana
Phone UN 1-4531 — LD 81

Memo to Management:

TO PUMP OR NOT TO PUMP *EFFICIENTLY* IS THE QUESTION and PEPA has the answer

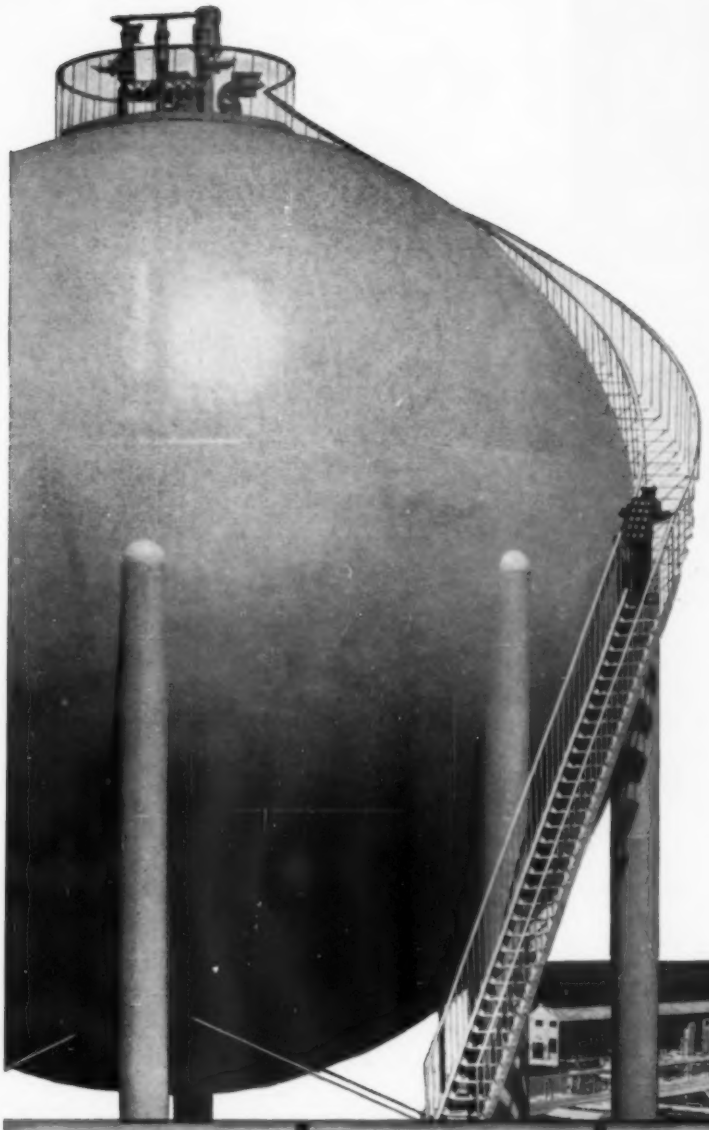
The question of dependable, efficient power for oil field pumping has been answered time and again with economical utility electric power. In most instances there is no substitute for the savings in maintenance, money and manpower provided through the use of purchased electric power. And this record of efficiency is not restricted to any one section of the petroleum industry. From the oil fields to the refinery it will pay you to investigate possible savings you may derive. Contact your Utility Electric Power Company for details.

A list of P.E.P.A. members will be furnished on request

PETROLEUM POWER ELECTRIC ASSOCIATION

BOX 35006, DALLAS 35, TEXAS

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

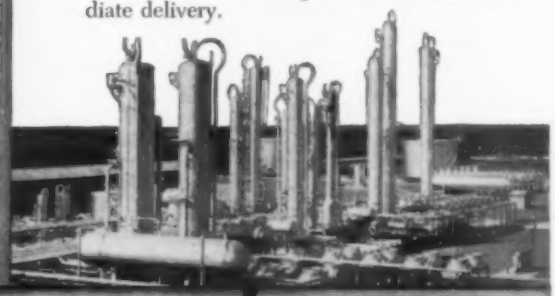


Tough, colorful, lasting beauty!

Take those pumps and rigs in the oil fields—or those tanks and pipelines in the refineries! Each needs the tough, colorful, lasting beauty that Rust-Oleum provides. If the surface is rusty, Rust-Oleum 769 Damp-Proof Red Primer can be applied *right over the sound rusted surface* after removing rust scale and loose rust. Special Rust-Oleum Oil Field Finishes match the original equipment colors on pumps and rigs – while other long-lasting Rust-Oleum coatings protect costly tanks and pipe lines.

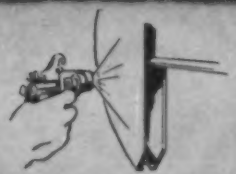
They're specially made for oil field use – tough, flexible, easy-to-use on the spot by brush or spray! They dry to firm, glossy finishes that resist sun, fumes, heat, moisture, weathering, and blowing dust and sand.

Try Rust-Oleum . . . your Rust-Oleum Distributor maintains complete stocks for immediate delivery.

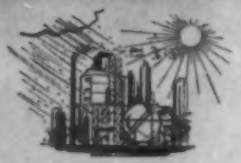


Apply Rust-Oleum 769 Damp-Proof Red Primer directly over sound rusted surfaces.

Follow-up with the Rust-Oleum finish coating in the color of your choice



By brush or spray – the Rust-Oleum system provides tough, colorful, lasting beauty.



Dries to a firm finish that resists sun, fumes, heat, weathering, and blowing dust and sand.

RUST-OLEUM®

There is only one Rust-Oleum. Distinctive as your own fingerprint.

STOPS RUST!®

Mail coupon today for FREE TEST SAMPLE

RUST-OLEUM CORPORATION
2584 Oakton Street Evanston, Ill.
Dallas Branch: 3200 McKinney, Dallas, Tex.

- ☐ Free test sample of 769 Damp-Proof Red Primer to be applied directly over sound rusted surfaces.
- ☐ Complete literature with color charts.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

NIGHT AND DAY

twenty-four hour service

PUMPS • WATER WELLS • WATER TREATMENT

Layne knows that an unfailing supply of water is vital, whether it be for municipal, industrial or agricultural use. With Associate Companies located throughout the world, Layne can provide the speed, the trained technicians and the quality parts to remedy your water problem. Over 75 years of experience accounts for the ever increasing list of customers who depend on Layne for service. For service night and day, call the Man From Layne.

Write for Layne Service Bulletin 100.

LAYNE OFFERS COMPLETE WATER SERVICE: Initial Surveys • explorations • recommendations, site selection • foundation and soil-sampling • well drilling well casing and screen • pump design, manufacture and installation • construction of water systems • maintenance and service • chemical treatment of water wells water treatment—all backed by Layne Research. Layne services do not replace, but coordinate with the services of consulting, plant and city engineers.

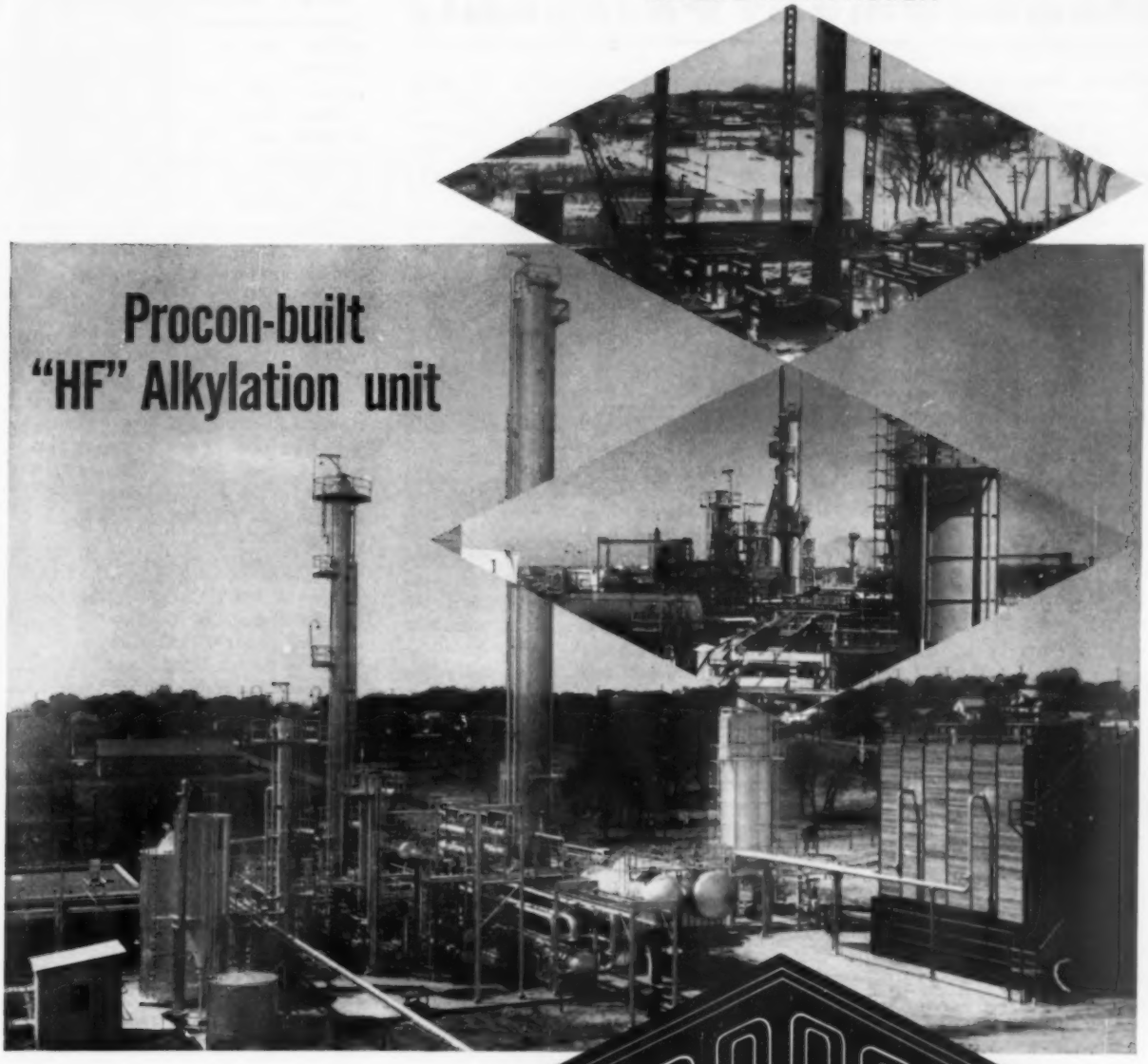
LAYNE & BOWLER, INC., MEMPHIS

General Offices and Factory, Memphis 8, Tenn.

LAYNE ASSOCIATE COMPANIES THROUGHOUT THE WORLD

SALES REPRESENTATIVES IN MAJOR CITIES

ON-SITE WITH PROCON



Procon-built "HF" Alkylation unit

... on-stream ahead of schedule

Maintaining schedule during the construction of a processing unit requires the precise co-ordination and timing of a series of design, engineering, procurement and construction details. But to complete ahead of schedule requires the extras in experience . . . in judgement, that save minutes and days. A right decision . . . a proper procedure . . . a new technique, these are the *experience factors* that help PROCON build better and on time.

Procon completed this "HF" Alkylation unit, built for Midland Cooperatives, Inc., days ahead of schedule. Midland located in Cushing, Oklahoma, uses the high octane alkylate to supplement its premium gasoline.

Turnaround, unit revamping, one unit or a complete refinery from the ground up . . . whatever your requirement you can trust the entire job to PROCON.

PROCON®

WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL, AND CHEMICAL INDUSTRIES

PROCON *Incorporated*

1111 MT. PROSPECT ROAD,
DES PLAINES, ILLINOIS, U. S. A.

PROCON INTERNATIONAL S. A., CHICAGO, ILL., U. S. A.
PROCON (CANADA) LIMITED, TORONTO, CANADA
PROCON (GREAT BRITAIN) LIMITED, LONDON, ENGLAND
PROCON PTY. LIMITED, SYDNEY, AUSTRALIA
PROCOFRANCE S. a. R. L., PARIS, FRANCE
PROCON LIMITADA, SAO PAULO, BRAZIL
PACIFIC PROCON LIMITED, MANILA, P. I.
VICAPROCON, S. A., CARACAS, VENEZUELA

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Management Personals

Paul H. Weyrauch has been promoted to treasury coordinator for Gulf Oil Corporation at Houston. He had been manager of domestic banking for Gulf since 1959, and will be on the staff of K. E. Rotegard, manager of the services department in Houston.

Weyrauch will direct the financial activities of the domestic operating departments.

C. N. Bailey, assistant controller of the Humble Division, Humble Oil and Refining Company was named regional controller. **William Grant, Jr.,** assistant manager of the employee relations department of the Humble Division, moved to regional employee relations manager. **Charles Janvier,** area attorney for the Eastern area, Humble Division, is regional general counsel, and **A. F. Kent,** who has been information division head in the public relations department of the Esso Standard Division, is regional public relations manager.

G. T. Pearson, president of Hudson's Bay Oil and Gas Company Ltd. was elected chairman of the association's Alberta board of directors for the current year. **A. E. Feldmeyer,** president and managing director of Canadian Superior Oil of California, Ltd. was elected vice chairman.

New directors elected for two-year terms are: **E. A. Galvin,** Medallion Petroleums Ltd.; **J. F. Hardy,** Central-Del Rio Oils Ltd.; **C. Hay,** Royalite Oil Company, Ltd.; **W. C. Howells,** Texaco Canada Ltd.; **F. M. Jacobson,** Amurex Oil; **C. S. Lee,** Western Decalta Petroleum Ltd.; **T. Nitescu,** Canadian Fina Oil Ltd; **F. C. Osment,** Pan American Petroleum; **E. W. Scott,** Union Oil of California; **S. W. Shambaugh,** Reading & Bates Drilling; **S. Stewart,** Richfield; and **E. Trafford,** Colorado Oil and Gas.

John T. McCoy, coordinator of Tidewater's eastern division manufacturing department, was elected president of the Coordinating Research Council, Inc. **H. F. Barr,** chief engineer of Chevrolet division of General Motors, was elected vice president. **E. C. Belefski,** assistant treasurer of American Petroleum Institute, was re-elected treasurer and **Genevieve Walmsley** was re-elected to the post of secretary. **M. K. McLeod** was reappointed manager.

Coordinating Research Council is jointly sponsored by the American Petroleum Institute and the Society of Automotive Engineers, and conducts research investigations relating to fuels, lubricants, and automotive equipment. Seven of the directors of CRC represent the petroleum industry and seven represent the automotive industry. Over 700 scientists and engineers serve on the many CRC committees, which work on both military and civilian projects.

W. E. Glenn

J. P. Malott

Wayne E. Glenn, of Houston, and **J. P. Malott,** of Los Angeles, Calif. have been elected vice presidents of Continental Oil Company.

Glenn, who will continue to make his headquarters in Houston, will become vice president and executive assistant to Chas. A. Perlitz Jr., executive vice president. He formerly was general manager of Conoco's production department. Malott, formerly general manager of the company's western region, will make his new headquarters in Houston and will become vice president and general manager of production.

E. W. Webb, Houston, senior vice president of Continental Oil Company and one of the oil industry's leading petroleum production executives, retired February 28. Webb has been associated with the production phase of the oil industry for 40 years, having worked for six years with another oil company before joining Conoco in 1927. He was a production foreman at Seal Beach and Ventura, California, during his early years with Conoco, and later was a district superintendent and assistant general superintendent before becoming general production superintendent for the western region in 1946. He transferred to the company's executive offices in Houston in 1950 and was elected a company vice president the following year and senior vice president in 1958.

J. B. Cecil, Ponca City, Oklahoma, has been promoted to manager of Continental Oil Company's coordinating and planning department. Formerly assistant controller, he will make his new headquarters in Houston. **L. W. Clayton,** Ponca City, director of financial accounting, will succeed Cecil and **W. R. Reed,** Houston, assistant to the controller, has been promoted to director of financial accounting, replacing Clayton. Both men will make their headquarters at Ponca City.

Cecil E. Schultz, Ponca City, Oklahoma, was promoted to director of production and pipeline accounting for Continental Oil Company. He will succeed **E. H. Loosley,** who retired.

Schultz joined Conoco at Ponca City in 1944, was promoted in 1955 to assistant director of production and pipeline accounting, and was director of office methods for four years before his promotion in early 1960 to associate director of production and pipeline accounting.

Walter S. Hallanan, chairman of the National Petroleum Council, announced the appointment of **Vincent M. Brown** of Washington, D. C., as assistant secretary-treasurer of the Council. Brown has been identified with the work of the National Petroleum Council for 10 years, and has served in the capacity of statistician, analyst, and attorney on the Council staff.

L. W. Moore of Chicago, and **E. F. Bullard** of Tulsa, Oklahoma, have been elected directors of the board of Standard Oil Company (Indiana).

Moore joined Standard Oil in 1933, and has been president of American Oil since 1957.

Bullard is chairman of the board of Pan American Petroleum Corporation. He joined the Standard Oil organization in 1921, and was president of Pan American Petroleum from 1945 to 1958.

M. R. Hayes is the new general services department manager of Phillips Petroleum. Chief responsibilities will include operation of the Bartlesville, Oklahoma, office buildings and related facilities, the company's telephone, teletype, and radio communications systems; printing and office supplies; leasing of all warehouse and office space, and negotiation of all electric power and communications contracts.

He was named superintendent of the production department's western division in 1951 and became manager of all phases of the company's operations in Canada in 1958. He held this position until recently when Phillips exchanged all its holdings in Canada for common shares of Pacific Petroleums Ltd.

John H. Wiggins, since 1945 a public relations executive of Jersey Standard, joined the staff of the Thomas J. Deegan Company in the firm's New York headquarters. Before joining Jersey Wiggins was for eight years with the Associated Press and is a former editor of En Guarda Magazine, distributed in Latin America. He will supervise Deegan company's oil and natural gas interests.

W. R. Stott

▸ **William R. Stott,** vice president and a member of the board of directors, was elected an executive vice president and member of executive committee of Standard Oil Company (New Jersey).

Stott succeeds **Emile E. Soubry,** who plans to retire as a director in May. **Peter T. Lamont,** a vice president and director, has expressed the desire to retire and requested that his name not be put up for re-election for the board at the annual meeting of shareholders in May. **Stewart P. Coleman,** a vice president and director, retired April 1 for reasons of health.

P. J. Anderson

W. A. M. Greeven

Paul J. Anderson, Jersey Standard representative for the United Kingdom and Scandinavia and the company's Middle East representative in London and **W. A. M. Greeven,** regional coordinator for Europe, the Mediterranean and West Africa, were selected as nominees for the board of directors. **George M. Parker,** president and director of Esso Export Corp., succeeds Anderson.

▸ **William M. Allen** was elected a member of the board of Standard Oil Company of California, announced Chairman R. G. Follis. Allen has been president and a director of Boeing Airplane Company in Seattle since 1945.

▸ **Guillermo Rodriguez-Eraso** was elected to the board of Creole Petroleum Corporation, Venezuelan affiliate of Jersey Standard. He joined Creole in 1945, and in June, 1959, was appointed special assistant to the president.

▸ **Carl Illig** has succeeded **Forrest M. Darrough** as associate general counsel of Humble Oil & Refining Company, principal operating affiliate of Jersey Standard. Darrough is now general counsel of Humble, and recently succeeded **Nelson Jones,** who was elected to the company's board of directors.

Illig moved to the headquarters staff of the Humble company from the Humble Division, where he has been serving as division general counsel and a member of the board of management. He joined Humble in 1934.

▸ **Philip D. Croll** was appointed manager of the editorial services division of Sun Oil Company's public relations department. Croll succeeds **George J. Bauer, Jr.,** who retired after 41 years service with Sun.

Croll became associated with Sun Oil in its accounting department in 1936. He transferred to the public relations department in 1948 where he has been in charge of editorial and economic research activities and more recently assisted in administration of the department.

▸ **John M. Proos** was named executive secretary of Layne Associates, a newly formed national organization to be headquartered in Memphis, to promote progress in the development and conservation of water and to provide technical information through research in the field of water. He is also district manager and vice president of Layne-Northern Company and serves as chairman of the board of Layne & Bowler, Inc.

J. M. Proos

▸ **L. F. McCollum,** president of Continental Oil Company, has been elected to the board of trustees of the California Institute of Technology.

DEATHS

▸ **Martin Sain,** 76, vice president and founder of SACOR, died February 2.

In compensation for his efforts on the industrial plan and of his deeds of charity, the Portuguese Government awarded him with the distinction of the Commander of the "Ordem de Cristo" and that of the "Grand Officer" of the "Ordem de Benemerencia." He was also Officer of the Legion of Honor.

▸ **Frederick T. Kafka,** area manager of Spanish Gulf Oil Company, Las Palmas, Canary Islands, was accidentally drowned on February 26 while fishing with his family. He was 41 years of age, and had been affiliated with Gulf since 1947 as a geophysicist in the United Sattes, North Africa, Sicily, Italy and the Canary Islands. A graduate of Oberlin College, Oberlin, Ohio, he received his Masters Degree from the University of Pittsburgh.

▸ **Chester Naramore,** 70, passed away January 3. He was the first chief of the Petroleum Division of the United States Bureau of Mines and was considered one of the earliest petroleum engineers.

Laugh with Barney

"Mama, what's a second story man?"

"Your father is one, dear. If I don't believe his first story, he always has another one ready."

* * *

A gossip is a person who puts two and two together — even if they're not.

* * *

A mother had been trying to stop her son from sucking his thumb. So far she had been unsuccessful. One day she told him, "Son, if you keep sucking your thumb your stomach will get bigger and bigger until finally it will burst." That scared the boy and he stopped. One day his mother was entertaining some friends and one of them was pregnant. The little boy pointed her out and said in a loud voice to his mother, "I know what she has been doing!"

* * *

The little boy was asked if he knew who Atlas was. "A giant who was supposed to support the world," answered the boy.

"Well, who supported Atlas?"

"I expect he must have married a rich wife."

* * *

A youthful figure is something you get when you ask a woman her age.

* * *

The big guns in business are generally those who have never been fired.

* * *

Why not put the designers of ladies bathing suits in charge of government budgets?

* * *

When asked how it felt to attend the dedication of his own statue, the honored man said, "Well, somehow you begin to feel differently about pigeons."

* * *

There's nothing like the first horseback ride to make a person feel better off.

* * *

He: Say something soft and sweet.
She: Custard pie.

* * *

"Let me kiss those tears away, honey," begged the ardent lover.

She fell into his arms and he was very busy for a few minutes. But the tears flowed on.

"Will nothing stop them?" he asked breathlessly.

"No, she murmured, "it's hay fever but go on with the treatment."

* * *

Robin: A sparrow with high blood pressure.

* * *

A bright high school graduate applied for his first job. He read the application blank which asked, "What machines can you operate?"

The youth studied hard, then wrote, "Slot and pinball."

* * *

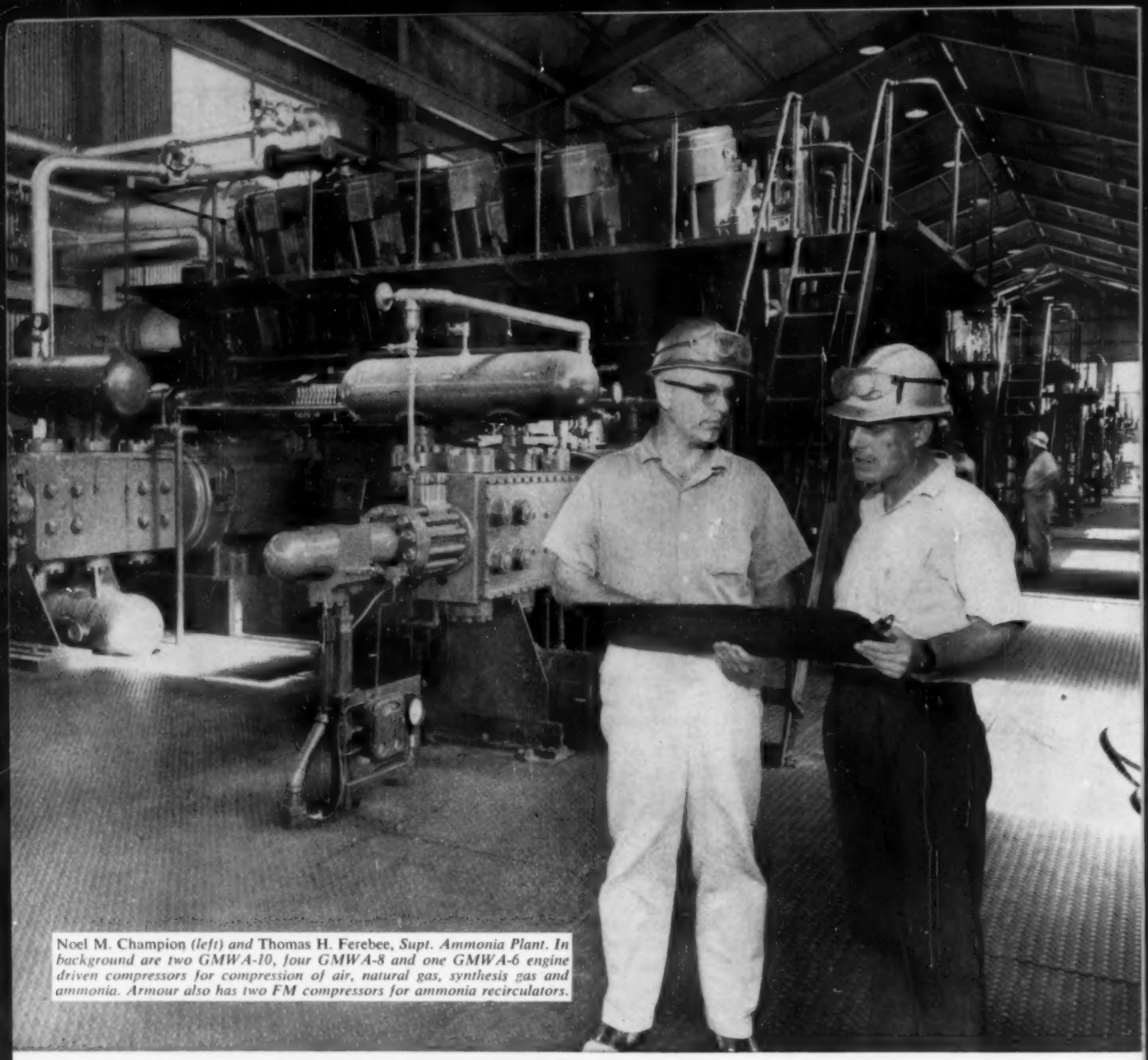
Said the amorous rooster to the reluctant hen, "You're chicken!"

* * *

Women are to blame for most of the lying men do. They insist on asking questions.

* * *

The one who thinks these jokes are
poor
Would straightaway change his
views
Could he compare the jokes we
print
With those we could not use.



Noel M. Champion *(left) and* Thomas H. Ferebee, *Supt. Ammonia Plant. In background are two GMWA-10, four GMWA-8 and one GMWA-6 engine driven compressors for compression of air, natural gas, synthesis gas and ammonia. Armour also has two FM compressors for ammonia recirculators.*

How Cooper-Bessemer service helps keep the ammonia flowing

At Armour Agricultural Chemical Co., Crystal City, Missouri, nine Cooper-Bessemer compressors play key roles in the manufacture of ammonia products. Round the clock, for five years, these units have given exceptional performance under the rigors of such problems as handling pressures up to 9000 psi.

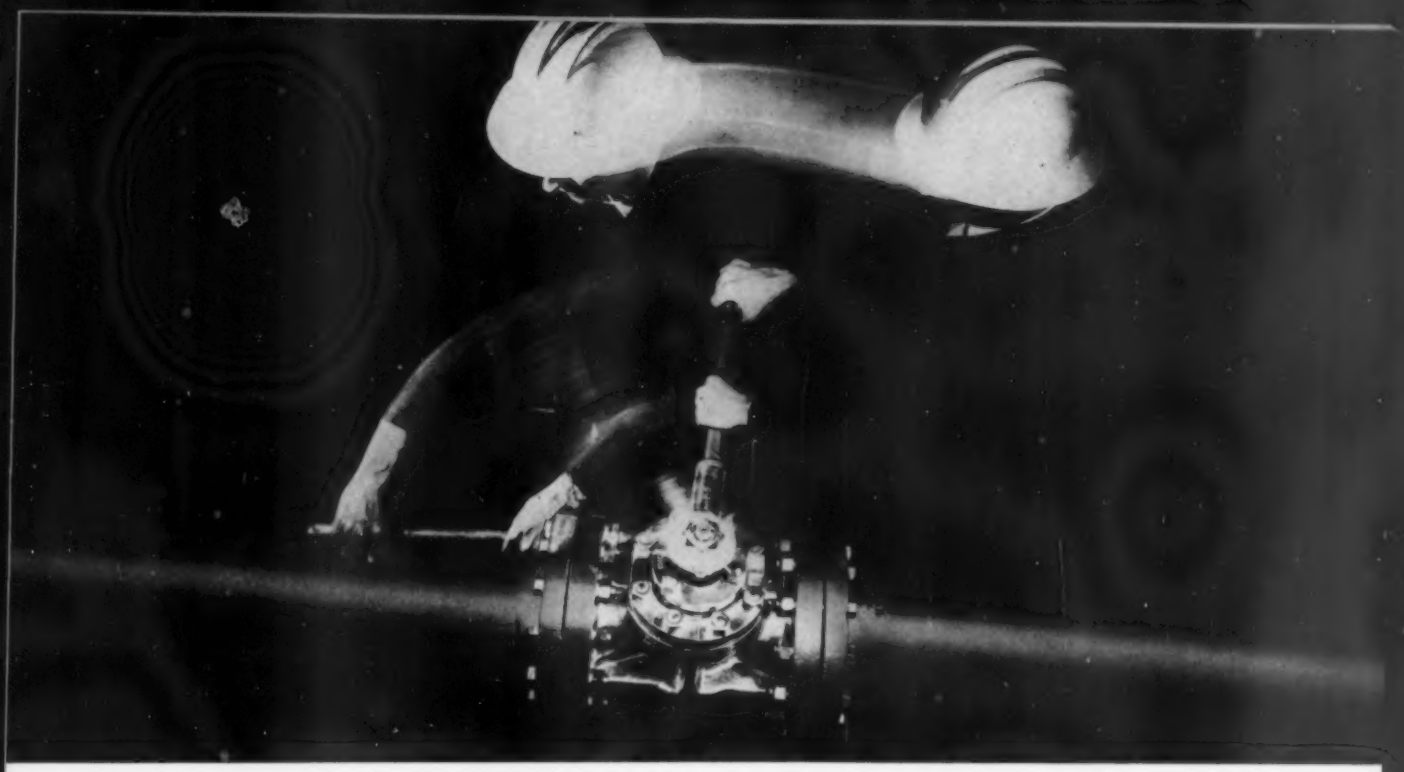
The performance of these C-B compressors has been backed by Cooper-Bessemer engineers in the St. Louis area and in Mt. Vernon, contributing helpful service for these high-pressure operations.

Cooper-Bessemer engineers will gladly help *you* plan compression facilities, and demonstrate how this unique service works for your benefit. Call the nearest office.

Cooper Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

ENGINES: GAS - DIESEL - GAS-DIESEL - GAS TURBINE
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL,
ENGINE, TURBINE OR MOTOR DRIVEN



Stroboscopic photo shows fast, smooth quarter turn closure of Rockwell-Nordstrom lubricated plug valves.

THESE LUBRICATED VALVES CLOSE 2 TO 5 TIMES FASTER

Rockwell-Nordstrom *lubricated* plug valves save time, reduce flow control errors because they close quickly, positively and easily with just a quarter turn. One man can open or close a dozen of these valves in the time it takes to laboriously wrestle one hand wheel on other types of valves.

Faster closure isn't the only advantage of Rockwell-Nordstrom lubricated plug valves. Their Sealdport pressurized lubrication system insures positive shut-off by creating powerful seals of hydraulically energized lubricant at the seat ports. And, isn't it just common sense that any lubricated mechanism will work better, longer and at far lower cost than a "dry" one? Get complete details on Rockwell-Nordstrom lubricated plug valves (the world's most complete line) by writing: *Rockwell Manufacturing Company, Pittsburgh 8, Pa.; Canadian Valve Licensee, Peacock Brothers Limited; Rockwell International S.A., Geneva, Switzerland.*

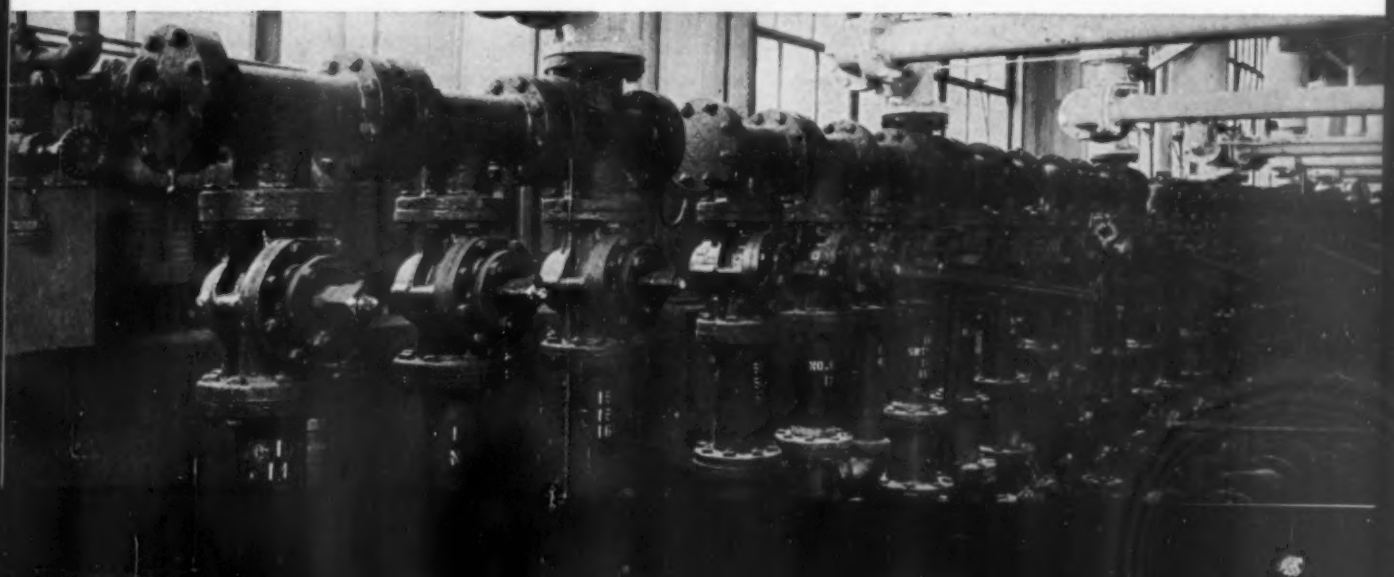
Lubrication Makes The Difference

ROCKWELL-Nordstrom VALVES

another fine product by

ROCKWELL

One man can open or close this refinery transfer manifold 3 times faster than three men winding handwheels on ordinary valves.



Are your costs too HIGH?

These pipeliners are cutting costs – using SIE control systems

DISPATCHERS CONSOLE used by Cherokee Pipe Line Company for automatic control of liquid line.

SIEMARC Supervisory Systems provide automatic monitoring and remote control for many industrial operations and processes including the petroleum installation pictured. Measuring, data gathering, telemetering, logging, display, indicating and computing are all integrated in the system. Both solid-state and relay components are used as dictated by proper engineering design. Transistors and semiconductor diodes are utilized in all high-speed switching and logic circuits including encoders, decoders, analog-to-digital converters, deviation detectors and magnetic drum circuitry. Separate electric logging typewriters record data and alarms.

POWER LEVEL CONTROLLER used by Shell Pipe Line Corp. Ozark System for maximum pumping station operating economy.

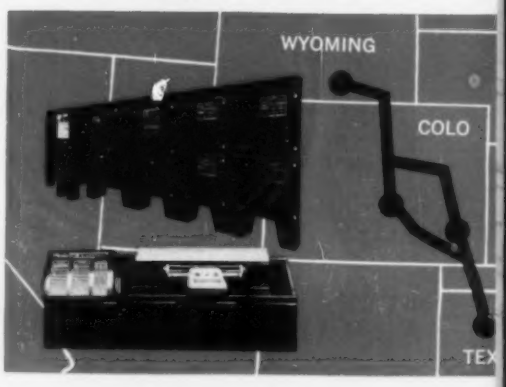
Completely unattended operation of a multi-unit pumping station is possible with Power Level Controllers used by Shell Pipe Line Corp. The unit accepts signals from flow and pressure pickups and makes logic decisions to bring proper combinations of pump units on or off stream automatically. It may be connected to the supervisory control system to permit reset of power levels from a central office dispatching console.

COMPRESSOR STATION CONTROL CONSOLE including complete engine control equipment for automatic station operation and safety.

For gas transmission automation, the basic SIEMARC system can be coupled with Log-Alarm Shutdown and Engine Control-Sequence units. Building block design throughout allows SIE to fit your needs exactly.

DISPATCH PANEL used by Colorado Interstate Gas Company.

In the Colorado Interstate Gas Company installation shown, dispatchers transmit only desired discharge pressure settings; automation at each compressor station responds by maintaining the selected value for optimum station economy. If communication links fail, local automation operates without interruption. Log-Alarm units insure station safety. Dispatchers are alerted only when trouble occurs.



Pioneers in solid state systems for supervisory control and telemetering.

DAY | NIGHT | SERVICE
Call: SUnset 2-2063
Houston, Texas

DRESSER ELECTRONICS

SIE DIVISION ONE OF THE DRESSER INDUSTRIES

10201 Westheimer, Houston 42, Texas

The first volume in a series on how SIE handles supervisory control and automation for the petroleum industry is now available. The booklet gives the ABC's of land line codes, binary techniques — and many more of the basics. A letter brings you "The ABC's of Industrial Telemetering."

INDUSTRY-WIDE USE

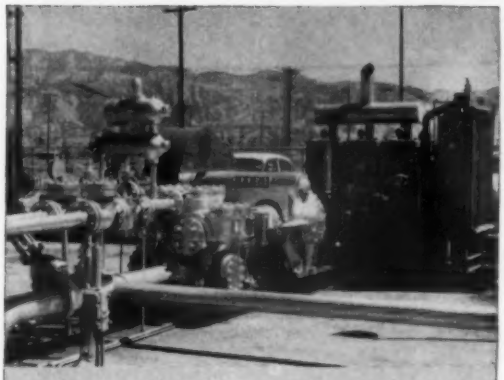
BUILT ON OUTSTANDING PERFORMANCE

Not too long ago Gaso Pumps were known principally for their work in pipe line service.

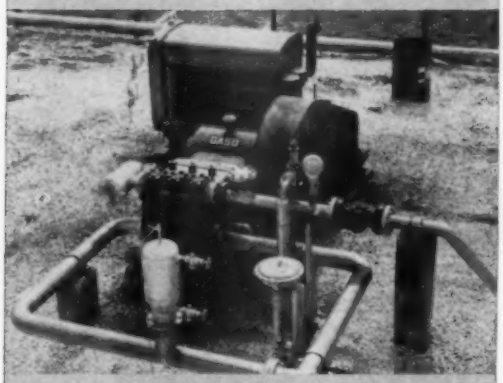
Today they are specified in ever increasing volume by all branches of the industry.

The reason is obvious: Engineers concerned with water flooding, salt water disposal, oil well cementing, oil well acidizing and fracturing, LPG underground storage, mine water disposal and other operations involving pumps are just as interested as pipe line engineers in the extra years of trouble-free service which have become a Gaso trademark.

Performance speaks a universal language, and it's performance upon which Gaso leadership is built.



GASO PUMPS IN PIPELINE SERVICE



GASO PUMPS
FOR SALT WATER DISPOSAL

GASO PUMPS IN LPG SERVICE

GASO PUMPS
for every oil industry need

SEND FOR OUR
1960 - 1961
CATALOG

DISTRIBUTORS:

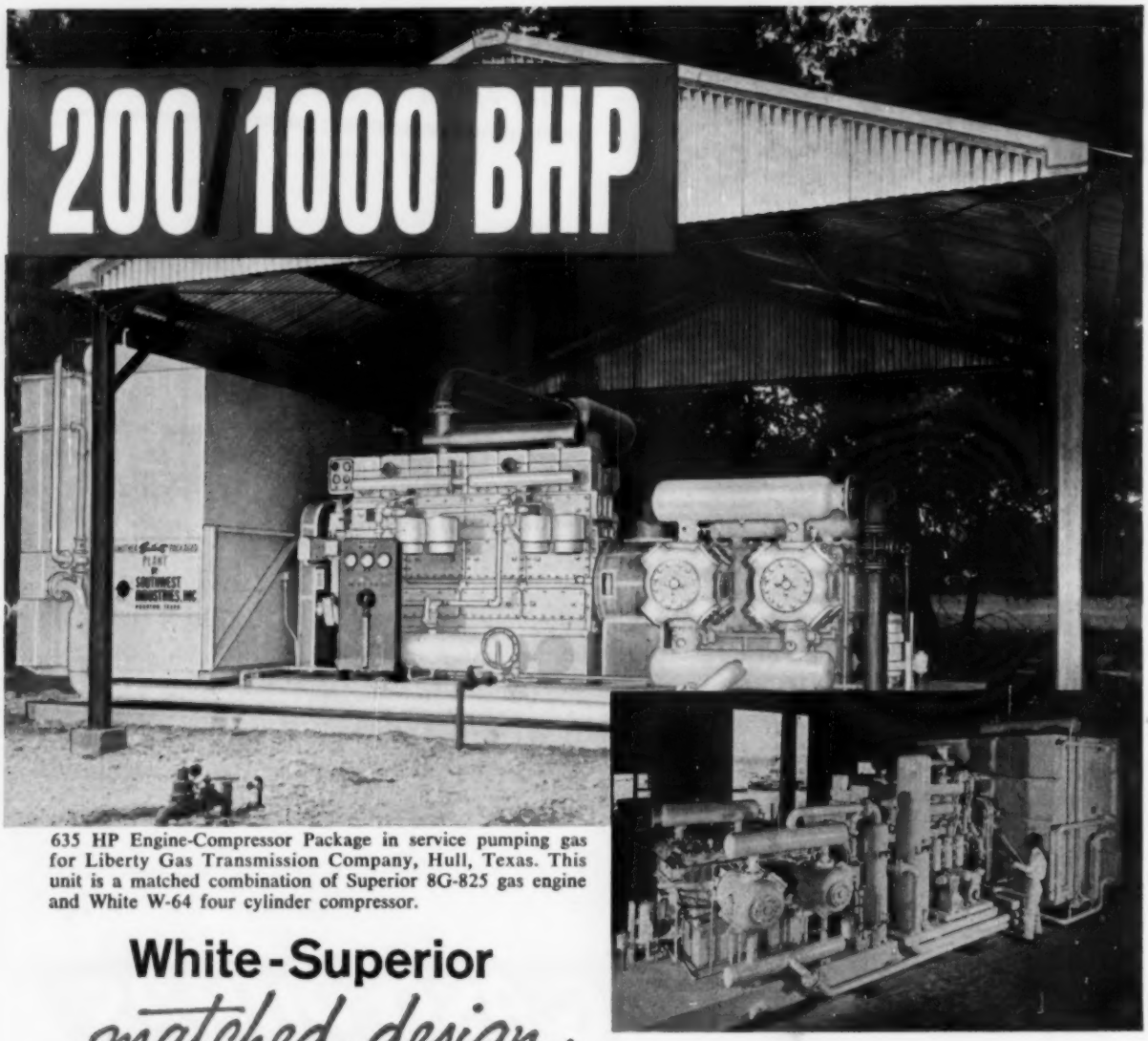
Farmington, N. M. – Gaso Pump & Burner Mfg. Co.
Shreveport, La., Odessa, Texas, Brookhaven and Tinsley, Miss. – W. L. Somner Company
Houston, Texas – Texas Pump & Compressor Company
Wichita Falls, Texas – Pump Engineering Co.
Evansville, Ind. – Hague Equipment Co., Inc.
Long Beach and Bakersfield, Cal. – Power Pumps, Inc.
Casper, Wyoming – Lufkin Foundry & Machine Co.
Edmonton, Alberta – Lufkin Machine Co., Ltd.

PUMPS FOR:

CRUDE OIL GATHERING LINES · CRUDE OIL PIPE LINES · PETROLEUM PRODUCTS PIPE LINES · GASOLINE PLANTS-ABSORPTION OIL · LPG UNDERGROUND STORAGE · WATER FLOODING · OIL WELL CEMENTING · OIL WELL ACIDIZING AND FRACTURING · SMALL VACUUM SYSTEMS

GASO PUMP & BURNER MFG. CO. First and Lansing Streets, Tulsa Oklahoma · Export Office: Empire State Building, New York, N. Y.

200/1000 BHP



635 HP Engine-Compressor Package in service pumping gas for Liberty Gas Transmission Company, Hull, Texas. This unit is a matched combination of Superior 8G-825 gas engine and White W-64 four cylinder compressor.

White-Superior *matched design* ENGINE-COMPRESSORS

White Diesel announces a line of medium speed, heavy duty, balanced opposed compressors, 200 to 1000 BHP, specifically engineered for combination with Superior natural gas engines. The complete, compact, *matched design* engine-compressor package provides continuous, heavy duty service for gas gathering, gas lifting, repressuring and booster applications.

Six inch stroke White compressors coupled to 9 inch and 10½ inch stroke Superior oil field gas engines provide optimum combinations of piston speed, horsepower and service life. Model W-62, two-cylinder compressor, ranges from 200 BHP with Superior 6G-510 gas engine to 635 BHP with 8G-825. Model W-64, four-cylinder compressor, is rated up to 1000 BHP with supercharged 8GX-825 gas engine. Standard cylinder sizes range from 4000 PSI, 2⅝" dia. to 85 PSI, 22½" dia., providing 68 different cylinders. Custom sizes and designs available.

Speed of direct-connected engines (no belts or gears) can be varied from 600 to 900 RPM for easy control of compressor unit. Compressor cylinders can be easily changed on same frame to suit changing volume or pressure conditions.

Get new Bulletin 124 from White oil field representatives . . . or write today to:

Superior ENGINES | White DIESEL

White Diesel
WHITE DIESEL ENGINE DIVISION
THE WHITE MOTOR COMPANY
Plant and General Offices: Springfield, Ohio

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

For Complete FREE Information on—

- NEW EQUIPMENT
- LITERATURE
- ADVERTISED PRODUCTS

Let us help keep you alerted to the newest in equipment and services in your fast changing industry.

1. For more information on ***Advertised Products*** or ***Services*** in this issue . . . list the page number of the advertisement and name of the advertiser.
2. For more information on ***New Equipment, Catalogs*** and ***Sales Literature*** reviewed in this issue, circle the code number on the card below corresponding to the code number of the New Equipment or Literature item.
3. Then print or type your name, title, company and complete mailing address . . . detach and drop in the mail.

LIST HERE for more information about ADVERTISED PRODUCTS . . . .

CIRCLE NUMBERS for NEW EQUIPMENT AND LITERATURE items . . . . . .

Send me further details on . . . **Void After 90 Days — APRIL, 1961**

PRODUCTS or SERVICES ADVERTISED on the pages I have indicated below:

Page____ Company____ Page____ Company____

Page____ Company____ Page____ Company____

Page____ Company____ Page____ Company____

NEW EQUIPMENT or LITERATURE items corresponding to code numbers circled below:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175
176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200

☐ PE, Drilling-Producing ☐ Petro/Chem Engineer ☐ Pipeline Engineer ☐ PE for Management

Please print or type below. ☐ **Please send me index of 1960 content.**

NAME____ TITLE____

COMPANY____

ADDRESS____

Postage Will Be Paid by Addressee

POSTAGE STAMPS REQUIRED IN COUNTRIES OTHER THAN U. S. A.

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD

FIRST CLASS PERMIT No. 1091, DALLAS, TEXAS

the Petroleum Engineer

PUBLISHING COMPANY

P. O. Box 1589 — DALLAS 21, TEXAS

Use these Ready-Reply Cards for prompt action on your request.

For Complete FREE Information on—

- NEW EQUIPMENT
- LITERATURE
- ADVERTISED PRODUCTS

1. For more information on ***Advertised Products*** or ***Services*** in this issue . . . list the page number of the advertisement and name of the advertiser.
2. For more information on ***New Equipment, Catalogs*** and ***Sales Literature*** reviewed in this issue, circle the code number on the card below corresponding to the code number of the New Equipment or Literature item.
3. Then print or type your name, title, company and complete mailing address . . . detach and drop in the mail.

These Ready-Reply Cards bring you fast action for information on the new equipment and service items listed . . . and complete information on the products and services advertised in this issue.

Postage Will Be Paid by Addressee

POSTAGE STAMPS REQUIRED IN COUNTRIES OTHER THAN U. S. A.

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD
FIRST CLASS PERMIT No. 1091, DALLAS, TEXAS

the Petroleum **Engineer**
PUBLISHING COMPANY
P. O. Box 1589 — DALLAS 21, TEXAS

Send me further details on . . . **Void After 90 Days — APRIL, 1961**

PRODUCTS or SERVICES ADVERTISED on the pages I have indicated below:

Page____ Company____ Page____ Company____

Page____ Company____ Page____ Company____

Page____ Company____ Page____ Company____

NEW EQUIPMENT or LITERATURE items corresponding to code numbers circled below:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175
176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200

☐ PE, Drilling-Producing ☐ Petro/Chem Engineer ☐ Pipeline Engineer ☐ PE for Management

Please print or type below. ☐ Please send me index of 1960 content.

NAME____ TITLE____

COMPANY____

ADDRESS____

LIST HERE for more information about ADVERTISED PRODUCTS . . . .

CIRCLE NUMBERS for NEW EQUIPMENT AND LITERATURE items . . . . . .

Parking garage in Bristol, England

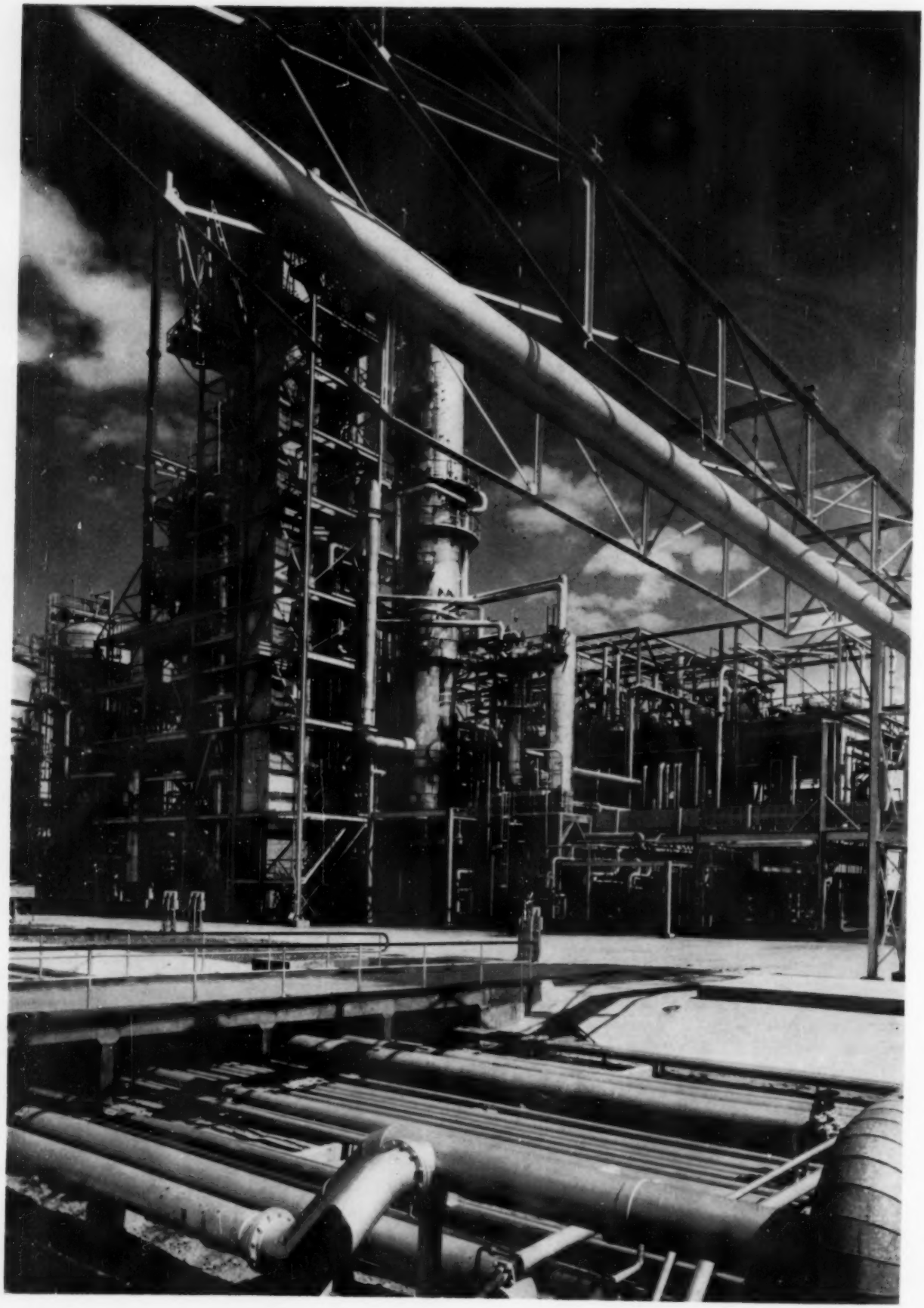
"The marketing concept—the orientation of business to the customer and his needs—has brought about a revolution in business, but not yet in adequate measure in the oil industry. While demand was strong and steady our task was to find oil and bring it to the customer and we had little incentive to blaze new marketing trails. Now it is high time for us to do so."

—M. J. Rathbone, President

ESSO

Standard Oil Company (New Jersey)

(WHOSE PRINCIPAL U. S. OPERATING AFFILIATE IS HUMBLE OIL & REFINING COMPANY)



AUSTRALIA
-BEST PLACE TO HAVE AN OIL WELL

J. M. RAYNER
Director, Australian Bureau of Mineral Resources

IF YOU HAD a big oil well coming in and could choose the place for it, what spot would you pick?

There are a lot of oil men who would choose Australia.

. . . the place where the single biggest import item is oil and oil products.

. . . the place where markets are steadily expanding for everything from asphalt to plastics and a still higher potential appears to be certain.

. . . the place where the government has $6 million a year available to stimulate exploration.

. . . the place where refineries and petrochemical complexes are growing at a rapid pace.

. . . the place where the political system and business climate are reliable.

. . . the place where lack of cheap energy is an unwelcome brake on full progress.

. . . the place where a breakthrough in oil production seems inevitable.

AUSTRALIA HAS AMPLE refining capacity and new construction will keep up with demand. Refinery runs and the national consumption are about the same, some 225,000 b/d.

What the country needs right now is its own petroleum supply. In 1959, oil imports cost $297 million, the single biggest import item. To stem the tide of rising oil costs, the Commonwealth Government increased the sales tax on cars from 30% to 40% and also encourages oil exploration by making available about $6 million a year to subsidize the search for oil.

Photo is catalytic cracking unit at Shell's Geelong refinery. Shell's investment in Australia is nearing $270 million.

Under the Petroleum Search Subsidy Act of 1959, the government can grant companies as much as 50% on approved stratigraphic drilling operations and geophysical surveys, 66⅔% on off-structure drilling operations, 50% on certain bore-hole surveys and 100% on the electrical bore-hole survey of a water well.

Among 1960 applications approved for subsidies, were those of Australian Oil and Gas, Frome-Broken Hill and Associated Australian Oilfields for stratigraphic drilling operations; of Planet Exploration, Australian Oil and Gas, Geosurveys of Australia, and Associated Australian Oilfields for seismic and other surveys; of Phillips Petroleum for an aeromagnetic survey, and of Magellan Petroleum for off-structure drilling. The government provided about $1,200,000 of the cost of these projects.

Since 1958 the Commonwealth Government has allowed full remission of tax on any investment in an exploration company. Previously, only ⅓ was allowable as a tax deduction. Capital investment in oil exploration from overseas is welcome.

Large expenditures for oil exploration have been made since the search for oil began about 1900. At that time a town water well at Roma, Queensland, was being drilled and found natural gas. The gas blew off for about six years. When an attempt was finally made to use it the supply failed.

In 1959 oil exploration costs reached about $14 million as compared to $12.5 million in 1958. All told, until the last of 1960, approximately $160 million was spent in the search for oil and gas.

Total party months for all types of surveys was 339.65 in 1959 as compared with 230.5 in 1958 (see Table 1).

Concessions over more than half of Australia (some 3 million square miles) are held by some 60 companies. These are listed in Table 3. The first license for offshore exploration was granted to the Australian Pacific Oil Company, with Burmah Oil and Murphy Corporation each having a one-third interest. A preliminary reconnaissance will be made of the area, including the Fleurieu Peninsula, part of

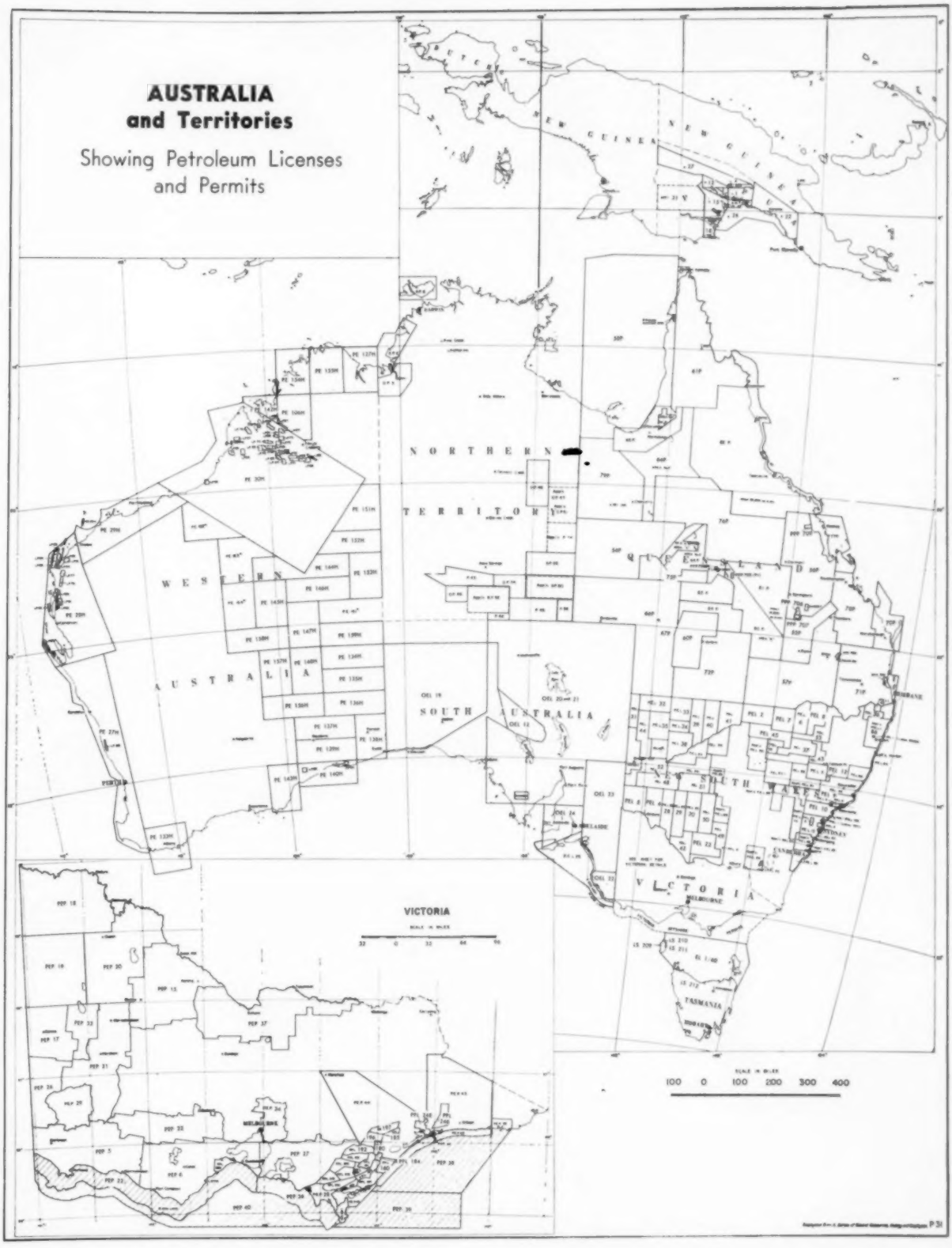
TABLE 3. PETROLEUM TENEMENTS BY STATES AND TERRITORIES

(In force 31 December 1960)

Number of Authority	Holder	Area (sq. miles)	Date of Expiry
QUEENSLAND			
Authority to Prospect (P)			
54P	Papuan Apinaipi Pet.	43,000	31/8/63
55P	Assoc. Aust. Oilfields & Assoc. Freney	13,100	30/9/61
56P	Assoc. Aust. Oilfields & Assoc. Freney	33,440	30/9/61
57P	Aust. O & G Corp. Union Oil Dev. Kern Co. Ltd.	43,000	30/9/63
58P	Santos & Delhi Aust. (50:50)	137,000	31/10/63
60P	L. H. Smart Oil Explor.	15,800	31/12/61
61P	Plymouth Oil Co.	45,900	31/3/62
64P	Carpentaria Aust. Swain Cree of Canada	37,700	31/3/62
65P	Assoc. Aust. Oilfields & Assoc. Freney (50:50)	15,500	31/12/61
66P & 67P	Santos & Delhi Aust.[1]	67,600	31/12/68
70P	Pacific American Oil	10,000	31/3/64
71P	Queensland American (50%)/Sunray/ Phillips (50%)	29,500	31/3/64
72P	Sunray & Phillips (50:50)	35,000	31/3/64
75P	Conorada Pet.	8,300	31/8/64
76P	Artesian Basin Oil Co.	57,900	31/10/64
77P	Reef Oil Co. Pty. Ltd.	12,000	30/9/64
78P	Nortex Australian Oils	19,400	31/12/62
79P	Australamerica Corp.	40,000	31/3/63
80P Area 'A'	Magellan (75%) Central Queensland (25%)	5,000	31/3/65
80P Area 'B'	Magellan Pet. Corp.	18,000	31/3/65
81P	Oil Development N.L.	19,500	30/6/62
82P	Triton of Australia	82,000	31/7/63
83P	Cordillera-Australian	9,300	30/6/65
84P	Sunray & Phillips(50:50)	9,600	30/6/65
Prospecting Petroleum Permit (PPP)			
697	Planet Exploration Co.	200	30/4/61
704	Standard Gas Pty. Ltd.	200	31/8/62
705	Longreach Oil Ltd.	188	28/2/61
706	Planet Exploration Co.	200	30/4/61
707	Planet Exploration Co.	200	30/4/61
708	Condamine Oil Ltd.	100	31/7/61
709	W.C. & H.J. Walz	200	31/10/61
NEW SOUTH WALES			
Petroleum Exploration License (PEL)			
2	Australian Oil & Gas	5,000	27/9/61
3	E. Gulliver	2,708	19/11/61
4	Australian Oil & Gas	5,000	27/6/61
5	Australian Oil & Gas	5,000	27/6/61
6	Australian Oil & Gas	1,500	9/8/61
7	Australian Oil & Gas	4,126	9/8/61
8	Australian Oil & Gas	3,750	9/8/61
9	Australian Oil & Gas	4,270	30/11/61
10	Australian Oil & Gas	3,330	30/11/61
11	P. E. Gauld	318	30/11/61
12	E. Gulliver	186	6/5/61
13	Australian Oil & Gas	3,566	31/5/61
23	Australian Oil & Gas	5,000	27/11/61
28	Planet Exploration Co.	4,860	8/7/61
29	Texas American Oil	5,000	8/7/61
30	Planet Exploration Co.	5,000	8/7/61
31	Clarence R. Basin Oil Exp.	2,500	8/7/61
32	Oil Development N.L.	4,569	17/7/61
33	L. H. Smart Oil Expl. Co.	4,148	10/9/61
34	L. H. Smart Oil Expl. Co.	2,055	10/9/61
35	Planet Exploration Co.	4,905	12/8/61
36	Builders Inc. Pty. Ltd.	1,790	22/10/61
37	Builders Inc. Pty. Ltd.	4,129	22/10/61
38	Builders Inc. Pty. Ltd.	5,000	22/10/61
39	Builders Inc. Pty. Ltd.	4,800	22/10/61
40	Builders Inc. Pty. Ltd.	4,910	22/10/61
41	Builders Inc. Pty. Ltd.	5,000	22/10/61
42	Builders Inc. Pty. Ltd.	3,260	22/10/61
43	Builders Inc. Pty. Ltd.	1,959	22/10/61
44	Texas American Oil Corp.	4,866	8/1/62
45	Lee Evans Australian Pet.	4,772	8/1/62
46	Australian Oil & Gas	4,700	26/11/62
48	North Australian Pet. Co.	4,889	5/5/61
49	Landa Australian Oil Ltd.	5,000	5/5/62
50	Landa Australian Oil Ltd.	5,000	5/5/62
51	Exploration Drlg. of Aust.	4,926	5/5/62
52	Sterling Australian Oil	5,000	5/5/62
53	Sterling Australian Oil	4,975	5/5/62
54	J.G. Fuller & W.J. Steeger	4,060	14/6/62
55	J.G. Fuller & W.J. Steeger	4,280	14/6/62
56	J.G. Fuller & W.J. Steeger	4,980	14/6/62
57	L. H. Smart Oil Expl. Co.	4,980	14/6/62
58	L. H. Smart Oil Expl. Co.	4,240	14/6/62
59	L. H. Smart Oil Expl. Co.	2,250	14/6/62
60	L. H. Smart Oil Expl. Co.	2,250	2/8/62
61	R. Walton	2,200	11/7/62
62	Woodside (Lakes Entr.)	280	11/7/62
63	L. H. Smart Oil Expl. Co.	180	9/9/62
64	L. H. Smart Oil Expl. Co.	1,080	9/9/62
Applications for Petroleum Exploration Licenses			
65	Strevens, Walton, Olarenshaw	280	Pending
73	A. J. Wood	5,000	Pending
85	M. A. Morandini	1,000	Pending
86	Clarence River Basin Oil	4,500	Pending
88	R. Walton	5,000	Pending
89	Overland Australian Oils	5,000	Pending
90	Appaloosa Oil of Aust.	5,000	Pending
91	L. H. Smart Oil Expl. Co.	1,000	Pending
92	Oil Development N.L.	2,460	Pending
Petroleum Prospecting License (PPL)			
2	Australian Oil & Gas Corp.	197	27/6/61
3	Australian Oil & Gas Corp.	200	27/6/61
4	C. J. Ellis	8.25	10/7/61
6	P. E. Gauld	48	11/9/61
Applications for Petroleum Prospecting Licenses			
22	Dome Oil & Minerals Synd.	107.5	Pending
24	Consolidated Oil Pty.	19.78	Pending
25	Consolidated Oil Pty.	64	Pending
Petroleum Title under Mining Act of 1906			
Mineral Lease			
No. 5056	Clarence R. Basin Oil Ex	108 acs. 3rds 19p	18/12/67
Petroleum Title under Mining Act of 1924			
Private Lands			
Lease No. 787	Olarenshaw, Harrison	4 acs. 3rds. 37p	22/10/68
VICTORIA			
Petroleum Prospecting License (PPL)			
157	Lakes Oil Ltd.	200	31/5/61
160	Lakes Oil Ltd. Victorian Oil N.L.	183	31/10/61
180, 215, 216	Victorian Oil N.L.	437	28/2/61
184, 185	Victorian Oil N.L.	111	30/4/61
191	Victorian Oil N.L.	139	31/8/61
212	Victorian Oil N.L.	167	31/12/60 renewal pending
196, 197, 201	Oilco Ltd.	482	30/9/61
248	Oilco Ltd.	141	31/10/61
192	A.P.M. Develop. Pty.	193	31/12/61
193	A.P.M. Develop. Pty.	182	31/8/61
199	Westralian Oil Ltd.	80	30/9/61
210	Westralian Oil Ltd.	191	31/10/61
246	A. E. Ekberg[2]	197	30/6/61
256	Oil Development N.L.	149	31/12/63
Petroleum Exploration Permits (PEP)			
5, 6	Frome Broken Hill Co.	8,635	31/5/61
22	Frome Broken Hill Co.	4,000	30/6/61
15	Woodside (Lakes Entr.)	4,530	31/3/61
21	Woodside (Lakes Entr.)	4,100	30/4/61
27	Woodside (Lakes Entr.)	2,750	31/12/61
42, 43, 44	Woodside (Lakes Entr.)	9,366	31/10/62
17	Dome Oil & Minerals Synd.	2,186	30/6/61
18, 19, 20	J. G. Fuller	13,789	
26	J. G. Fuller	1,805	31/12/61
28	Oil Development N.L.	366	31/12/61
29, 32, 34, 36	Oil Development N.L.	6,491	31/1/62
33	Ian McFarlane	1,183	31/1/62
38, 39, 40	Broken Hill Pty. Co.	12,850	31/3/62
37	Seismic Analysis Inc.	5,000	31/3/62
TASMANIA			
Coal & Oil License			
L.S.209	J. A. Adams	80 acres	14/4/61
L.S.210	W. M. Westley	1840 acres	14/4/61
L.S.211	S.P.J. Adams	2680 acres	14/4/61
L.S.212	W. M. Adams	2560 acres	24/5/61
Exploration License			
E.L. 1/60	Broken Hill Pty. Co.	28,975 sq m	11/4/61
SOUTH AUSTRALIA			
Oil Exploration License (OEL)			
12/1	Clarence R. Basin Oil	8,900	6/5/61
19/1	Exoil Pty. Ltd.	85,776	30/9/62
20/1	Delhi Australian Pet.	88,325	28/2/64
21/1	Santos Ltd.	88,325	28/2/64
22/1	General Expl. of Aust.	4,900	30/4/64
23/1	Hackathorn Oils Ltd.	35,900	22/11/64
24/1	Geosurveys of Australia	11,650	31/3/62
25/1	Australian Pacific Oil	14,400	31/7/63
WESTERN AUSTRALIA			
Permits to Explore (H)			
27H	West Australian Pet.	52,000	22/10/61
28H	West Australian Pet.	51,000	22/10/61
29H	West Australian Pet.	31,100	22/10/61
30H	West Australian Pet.	151,600	22/10/61
106H	Westralian Oil Ltd.	11,800	28/9/61
127H	Gulf Oil Synd.	13,800	28/3/61
133H	Jackson Explorations	15,750	2/9/61
134H	Exoil Pty. Ltd.	12,600	9/12/61
135H	Exoil Pty. Ltd.	12,600	9/12/61
136H	Exoil Pty. Ltd.	12,450	9/12/61
137H	Exoil Pty. Ltd.	12,300	9/12/61
138H	Exoil Pty. Ltd.	12,250	9/12/61
139H	Exoil Pty. Ltd.	12,200	9/12/61
140H	Exoil Pty. Ltd.	12,050	9/12/61
142H	Hawkstone Oil Co. Ltd.	5,200	8/4/61
143H	Exoil Pty. Ltd.	12,000	27/7/61
144H	Frome Broken Hill Co.	16,700	16/8/61
145H	Frome Broken Hill Co.	12,950	16/8/61
146H	Frome Broken Hill Co.	13,000	16/8/61
147H	Frome Broken Hill Co.	12,850	16/8/61
148H	Frome Broken Hill Co.	12,600	16/8/61
151H	Hackathorn Oils Pty. Ltd.	14,200	7/2/62
152H	Hackathorn Oils Pty. Ltd.	11,650	7/2/62
153H	Hackathorn Oils Pty. Ltd.	13,050	7/2/62
154H	D. Llewellyn Davis	13,800	8/2/62
155H	D. Llewellyn Davis	13,800	8/2/62
156H	Hunt Oil & Placid Oil	12,450	10/7/62
157H	Hunt Oil & Placid Oil	12,600	10/7/62
158H	Hunt Oil & Placid Oil	12,800	10/7/62
159H	Hunt Oil & Placid Oil	12,800	10/7/62
161H	Hunt Oil & Placid Oil	12,900	24/8/62
Applications for Permits to Explore			
162H	Aust. Oil Industries	11,300	pending
163H	Aust. Oil Industries	18,000	pending
164H	Aust. Oil Industries	12,950	pending
Licenses to Prospect (L P)			
51LP	West Aust. Pet. Pty.	191	19/6/61
52LP	West Aust. Pet. Pty.	198	6/10/61
53LP	West Aust. Pet. Pty.	196	16/12/61
54LP	West Aust. Pet. Pty.	198	7/5/61
55LP	West Aust. Pet. Pty.	196	14/7/61
56LP	West Aust. Pet. Pty.	200	22/2/61
57LP	Westralian Oil Ltd.	196	29/9/61
58LP	Assoc. Freney Oil Fields	120	27/10/61
59LP	Assoc. Freney Oil Fields	113	27/10/61
60LP	Assoc. Freney Oil Fields	113	27/10/61
61LP	Assoc. Freney Oil Fields	113	27/10/61
62LP	Assoc. Freney Oil Fields	112	27/10/61
63LP	West Aust. Pet. Pty.	118	29/9/61
64LP	Exoil Pty. Ltd.	189	12/11/61
65LP	Exoil Pty. Ltd.	200	12/11/61
66LP	West Aust. Pet. Pty.	200	18/1/62
67LP	West Aust. Pet. Pty.	199	20/4/62
68LP	West Aust. Pet. Pty.	195	17/5/62
69LP	West Aust. Pet. Pty.	175	17/5/62
70LP	West Aust. Pet. Pty.	193	17/5/62
71LP	West Aust. Pet. Pty.	187	17/5/62
72LP	West Aust. Pet. Pty.	195	17/5/62
73LP	West Aust. Pet. Pty.	189	17/5/62
74LP	West Aust. Pet. Pty.	186	17/5/62
75LP	West Aust. Pet. Pty.	191	17/5/62
76LP	West Aust. Pet. Pty.	193	17/5/62
77LP	West Aust. Pet. Pty.	196	17/5/62
78LP	West Aust. Pet. Pty.	190	17/5/62
79LP	West Aust. Pet. Pty.	199	17/5/62
80LP	West Aust. Pet. Pty.	189	17/5/62
81LP	West Aust. Pet. Pty.	193	17/5/62
82LP	West Aust. Pet. Pty.	198	17/5/62
83LP	West Aust. Pet. Pty.	193	17/5/62
84LP	West Aust. Pet. Pty.	187	17/5/62
85LP	West Aust. Pet. Pty.	187	17/5/62
86LP	West Aust. Pet. Pty.	189	17/5/62
Applications for Licenses to Prospect			
87LP	West Aust. Pet. Pty.	189	pending
88LP	Hawkstone Oil Co.	189	pending
89LP	West Aust. Pet. Pty.	192	pending
90LP	West Aust. Pet. Pty.	161	pending
91LP	West Aust. Pet. Pty.	134	pending
92LP	West Aust. Pet. Pty.	180	pending
93LP	West Aust. Pet. Pty.	195	pending
94LP	West Aust. Pet. Pty.	186	pending
NORTHERN TERRITORY			
Permit to Explore			
2	Assoc. Aust. Oilfields	9,900	23/12/62
3	Westralian & Oil Dev. (50:50)	7,400	23/6/63
8	Santos Ltd.	7,450	11/7/61
28	Three States Aust. Pet.	10,000	renewal pending
34	Flamingo Pet. Pty. Ltd.	4,578	renewal pending
36	Assoc. Freney Oil Fields	3,225	31/8/61
42	Flamingo Pet. Pty. Ltd.	1,500	18/8/61
43	Magellan Pet. Corp.	6,960	24/6/61
44	Continental Oil & Gas	7,233	pending
45	Geosurveys of Aust.	9,313	8/9/61
46	Magellan Pet. Corp.	2,818	9/11/61
48	Texas Amer. Oil Corp.	8,944	9/11/61
Applications for Permits to Explore			
47	Texas Australian Explor.	9,000	pending
50	Three States Australian	9,750	pending
51	Clarence River Basin Oil	8,864	pending
52	United Canso Oil & Gas	10,000	pending
PAPUA			
Permit to Explore			
12	Australasian Pet. Co.	1,704	30/6/61
14	Australasian Pet. Co.	1,365	30/6/61
15	Island Exploration Co.	4,938	13/6/61
18	Island Exploration Co.	2,148	2/9/61
22	Papuan Apinaipi Pet. Co.	8,740	10/8/63
24	Australasian Pet. Co.	692	25/10/61
26	Camelot Nominees Pty.	9,500	21/5/63
27	Australasian Pet. Co.	8,930	13/5/63
Application for Permit to Explore			
31	Triton Corp.	10,000	pending
License to Prospect			
1	Australasian Pet. Co.	2,705	30/10/61
2 & 3	Island Exploration Co.	811	30/6/61

[1] Checkerboarded and interrelated.

[2] (deceased) Corresp. to: Dome Oil & Minerals Synd N.L.


AUSTRALIA
and Territories
Showing Petroleum Licenses
and Permits
NORTHERN
TERRITORY
WESTERN
AUSTRALIA
SOUTH
AUSTRALIA
QUEENSLAND
NEW SOUTH WALES
VICTORIA
TASMANIA
VICTORIA
100 0 100 200 300 400

Barge shipments en route to Youngstown's four strategic stock points

STOCKS

24-hour service on Youngstown Orange Band pipe from in-transit stocks

CASING. Get all weights in four grades of seamless casing from 4½" through 13⅜" O. D. API (long or short) T&C in H-40, J-55, N-80 and P-110. Youngstown's Buttress T&C, Extreme Line and Speedtite integral joints in J-55, N-80 and P-110.

TUBING. Order H-40, J-55, N-80, P-105 . . . threaded and coupled, threads only or plain end, either API External Upset or API Non-Upset. There are special non-API upsets also available.

DRILL PIPE. Grade D, E, plus Youngstown exclusive X-95 and X-105 for low cost top performance in tough deep holes. Get it in standard and light weights, sizes 2⅜" to 6⅝" O.D. Choose plain end or threaded with internal, external or internal-external upset, all compatible with all tool joints.

Youngstown 24-hour service from in-transit stocks and immediate shipment direct from mill stocks mean fast, reliable delivery of Orange Band pipe when and where you need it. And Youngstown backs its quality with the talents of the largest field engineering service team in the Oil Country. Get pipe you can count on. Get the service you want. Order Orange Band Pipe from Youngstown.

Youngstown – growing force in steel

For full details on Orange Band Tubular Goods, write to: Dept. 2-A,
The Youngstown Sheet and Tube Company, Youngstown, Ohio

Table 1. 1959 Oil Exploration Surveys.

State or Territory	Type of survey and party months				
	Seismic	Gravity	Magnetic	Air photo	Geological
Queensland	17.45	25.25	5	2	56.75
New South Wales	—	10	1	—	37.0
Victoria	2	3.4	—	—	9.25
South Australia	4.0	2.0	—	—	31.25
Western Australia	12.0	7.5	3	1	43.25
Northern Territory	—	5.5	—	—	39.75
Papua-New Guinea	8	8.7	—	—	6.5
Tasmania	—	—	—	—	—
Totals	43.45	62.45	9	3	223.75

Table 2. Wells and Footage Drilled.

State or Territory	To 1945		1946 to 30/9/59	
	Wells	Footage	Wells	Footage
New Guinea	12	8,334	2	933
Papua	24	31,267	23	160,814
Queensland	46	158,324	42	139,639
New South Wales	13	38,654	26	54,086
Victoria	119	162,519	22	54,571
Tasmania	21	14,288	—	—
South Australia	38	40,765	58	58,094
Western Australia	10	15,927	77	269,839
Northern Territory	—	—	1	932
Totals	283	470,078	243	738,906

Kangaroo Island and a stretch of ocean southward to the Victorian border between 3 and 15 miles out to sea.

Nearly 600 Wells Drilled

In 1959, 51 wells were drilled. Table 2 lists wells drilled in the different states or territories and footage. Now close to 600 wells have been drilled. The cumulative knowledge coming from this expanding program will provide more and more information for better exploration.

Deepest well is Cape Range No. 2, which went to 15,170 ft. Recently, however, Phillips and Sunray Mid-Continent announces a 16,000-ft test in Queensland.

Although no commercial production has been proved there have been several interesting gas and/or oil discoveries. In the Roma area of Queensland, potential output of 9000 mcf/d of natural gas is confirmed for the Pickanjinnie (6500 mcf/d), Latemore, Timbury Hills and Hospital Hill wells drilled by Associated Freney Oil Fields, Associated Australian Oilfields and Papuan Apinaipi Petroleum Company. Up to 70,000 cu ft a day will be supplied through 2-in. and 3-in. pipeline 3½ miles long to Roma power station from Timbury Hills and Hospital Hill wells, as an experiment—the first commercial use of natural gas in Australia.

Other noteworthy wells were:

1953. Oil in Rough Range No. 1 (tested 500 b/d and set off renewed exploration effort).
1956. Gas in Kuru No. 1.
1958. Gas in Barikewa No. 1 (20,000 mcf/d).
Gas and oil in Puri No. 1, Papua. It tested 1000 to 1300 b/d oil 2500 mcf/d gas. Turned to water later.
1959. Gas and condensate in Port Campbell No. 1 (approximately 2000 mcf/d gas, later turned to water).
1960. Gas and condensate in Timbury Hills No. 2 and Pickanjinnie No. 1.

Drilling Contractors

There are 8 rigs operating in the continent. Three local Australian contractors are active in oil exploration drilling:

Oil Drilling and Exploration Ltd., 3 rigs (Nat. T20,55 and 80B)

Mines Administration Pty. Ltd., 3 rigs (Sullivan 300, Nat. T32 and 55)

W. L. Sides and Son Pty. Ltd., 1 rig (Cardwell H.L).

In addition, Delta Drilling Company has its own rig for the Delta-Santos program. Delta-Frome-Santos drilled its Innamincka No. 1 in South Australia to 12,637 ft in 1959. This had slight shows of oil and gas, was completed as a water well. The well cost $1,500,000, probably the most expensive water well in history. This and another test, however, drew a total government subsidy of more than $1 million.

Only pipelines in Australia are those built to carry crude or products in connection with refineries, terminals and bulk depots.

Refining

Details of the seven refineries operating in Australia are given below, including associated petrochemical and lubrication oil plants.

1. B. P. Refinery (Kwinana) Ltd., Kwinana, Western Australia, has crude capacity of 70,000 b/sd. Vacuum distillation 24,000 b/sd; hydrotreating 5600 b/sd; catalytic cracking 12,500 b/sd; and catalytic reforming 16,000 b/sd. There is a bitumen plant. Under construction is a 2000 b/sd lubricating oil refinery.

2. Shell Refining (Australia) Pty. Ltd., Geelong, Victoria. Crude capacity is 50,000 b/sd; catalytic cracking 17,500 b/cd; hydrofining 11,000 b/cd; catalytic reforming 6700 b/cd. Also the plant has a polymerization unit 2800 b/cd; a sulfuric acid unit of 40,000 T/yr and a bitumen unit.

Shell Chemical (Australia) will complete in 1961 a 12,000 T/yr detergent alkylate plant costing more than $2 million.

After completing its present program Shell's investment in Australia will be more than $270 million.

3. Shell Refining (Australia), Clyde, New South Wales, has a crude capacity of 20,000 b/cd; a catalytic reforming capacity of 6700 b/sd, and bitumen and lubricating oil units. A new 23,000 b/d catalytic cracker is planned for completion in 1963 at a cost of $38 million. Other projects will bring Shell's new investment here to $90 million.

Shell Chemical has 1000 T/yr epi-

ABOUT THE AUTHOR

J. M. Rayner is Director of the Bureau of Mineral Resources, Geology and Geophysics in the Australian Government Department of National Development. Graduated from the University of Sydney he later became a Fellow of the Institute of Physics (London) and a Member of The Australasian Institute of Mining and Metallurgical Engineers.

After spending periods with the Geological Survey of New South Wales, and with oil and metalliferous mining companies, he became Chief Geophysicist of the Bureau. He has travelled to Europe and North America on several occasions and has visited most of the oil fields of North America.

USE THIS ENVELOPE

to begin your subscription

to the Edition of THE PETROLEUM Engineer

edited expressly for you!

ONE HANDBOOK FREE WITH YOUR SUBSCRIPTION

SUBSCRIBERS: ORDER ADDITIONAL HANDBOOKS FOR ONLY $1 EACH

☐ **HOW TO BE A MANAGER**
Oil industry leaders tell you How to Define Your Goal, Prepare for Promotion, Check Your Progress—a 40-chapter series appearing in monthly issues of the "Engineer"; handbook contains all published to date.

Drilling and Producing Handbooks

☐ **HOW TO EVALUATE AND DEVELOP GAS-CONDENSATE RESERVOIRS**
W. C. Goodson's 8-chapter analysis of fundamentals for evaluating and developing Gas-Condensate Reservoirs; from discovery through economic depletion.

☐ **FUNDAMENTALS OF ROTARY DRILLING**
Newly revised 5th edition . . . 40 practical chapters on Drilling Techniques, Equipment Selection and Maintenance. Over 18,500 copies in use throughout the oil industry.

☐ **WELL WORKOVER HANDBOOK**
Tells when wells should be reworked . . . what techniques to use . . . how to check results.

☐ **FUNDAMENTALS OF OIL AND GAS PRODUCTION**
Tells the most successful production techniques . . . from the time a hole reaches pay dirt until production is flowing through the pipeline.

☐ **ELEMENTS OF WATER INJECTION**
J. Randolph Buck's analysis of the methods that bring maximum recovery at the greatest profit . . . covers all steps including planning the program and evaluating the results.

☐ **PRACTICAL PETROLEUM ENGINEERING PRACTICES**
The complete "Atlantic Lectures" as presented at the University of Texas and published exclusively by The Engineer. 14-chapters, 17 top-flight engineers and superintendents in production, research, drilling.

Refining-Petrochemicals Handbooks

☐ **REFINING FUNDAMENTALS**
A book-length series on petroleum refining processes by Dr. V. A. Kalichevsky.

☐ **MODERN GASOLINE PLANT DESIGN, ECONOMICS, OPERATION AND EQUIPMENT**
Ten chapters covering cold absorption, conventional absorption, abbreviated plants, refrigeration, dehydration, treating gas and water, plant instrumentation and plant cost estimating. Text amplified by 65 flow charts, tables, nomographs and check lists.

☐ **MECHANICAL DESIGN OF PROCESS TUBULAR HEATERS**
Dr. L. A. Mekler's step-by-step analysis of heaters design methods, engineering calculations, choice of materials and economics of design and operations.

☐ **CHOICE, DESIGN, AND MAINTENANCE OF CENTRIFUGAL PUMPS**
Covers pump design and operation, including most frequent troubles, their causes, how they can be minimized or eliminated.

☐ **FINNED TUBE HEAT EXCHANGER DESIGN METHODS**
Liquid-liquid, partial and complete condensing finned tube heat exchanger design.

☐ **HYDROCARBON ABSORPTION AND FRACTIONATION PROCESS DESIGN METHODS**
A 132-page review and comparison of the many methods proposed during recent years, plus design methods developed by Dr. W. C. Edmister.

Pipelining Handbooks

☐ **GAS TRANSMISSION AND PIPELINE FUNDAMENTALS**
Reprints of all chapters that have been published to date in this popular Personal Study Course. Complete series, each chapter written by a field-experienced authority . . . covers design, construction, measurement, communications, maintenance and all basic phases of modern pipelining.

☐ **PIPELINE HANDBOOK**
Annually revised special issue of the Pipeline Engineer — academic and advanced data presented in concise, easy-to-read tables, charts and methods descriptions for solving crude, products and gas pipeline problems.

☐ **CORROSION NOTEBOOK**
Sixty-four page manual on corrosion — what causes it, how to prevent it, how to find it, case histories, unique ideas in equipment and materials applications.

ENTER MY SUBSCRIPTION:

☐ New ☐ Renewal

PETROLEUM ENGINEER, Drilling & Producing	☐ $2 YR.	☐ $4 THREE YRS.
PETRO. CHEM ENGINEER	☐ $2 YR.	☐ $4 THREE YRS.
PIPELINE ENGINEER	☐ $2 YR.	☐ $4 THREE YRS.
PETROLEUM ENGINEER FOR MANAGEMENT	☐ $4 YR.	☐ $9 THREE YRS.

AND SEND:

One Free Handbook

Add. Handbook(s) @ $1

DO NOT WRITE BELOW

Name_____

Company_____

Title_____

Address_____ ☐ Home ☐ Company

City_____ Zone____ State_____

Please check division of industry engaged in:

☐ Drilling ☐ Drilling Contractor ☐ Producing
☐ Ind. Producer ☐ Pipe Line ☐ Pipe Line Contractor
☐ Natural Gasoline ☐ Refining ☐ Refining Contractor
☐ Petrochemical ☐ Supply ☐ Manufacturing

FOLD ON THIS LINE ⇩

FROM _____

FIRST CLASS
Permit No. 1091
DALLAS, TEXAS

BUSINESS REPLY MAIL
NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

POSTAGE WILL BE PAID BY

THE PETROLEUM Engineer
PUBLISHING COMPANY
P. O. BOX 1589
DALLAS 21, TEXAS

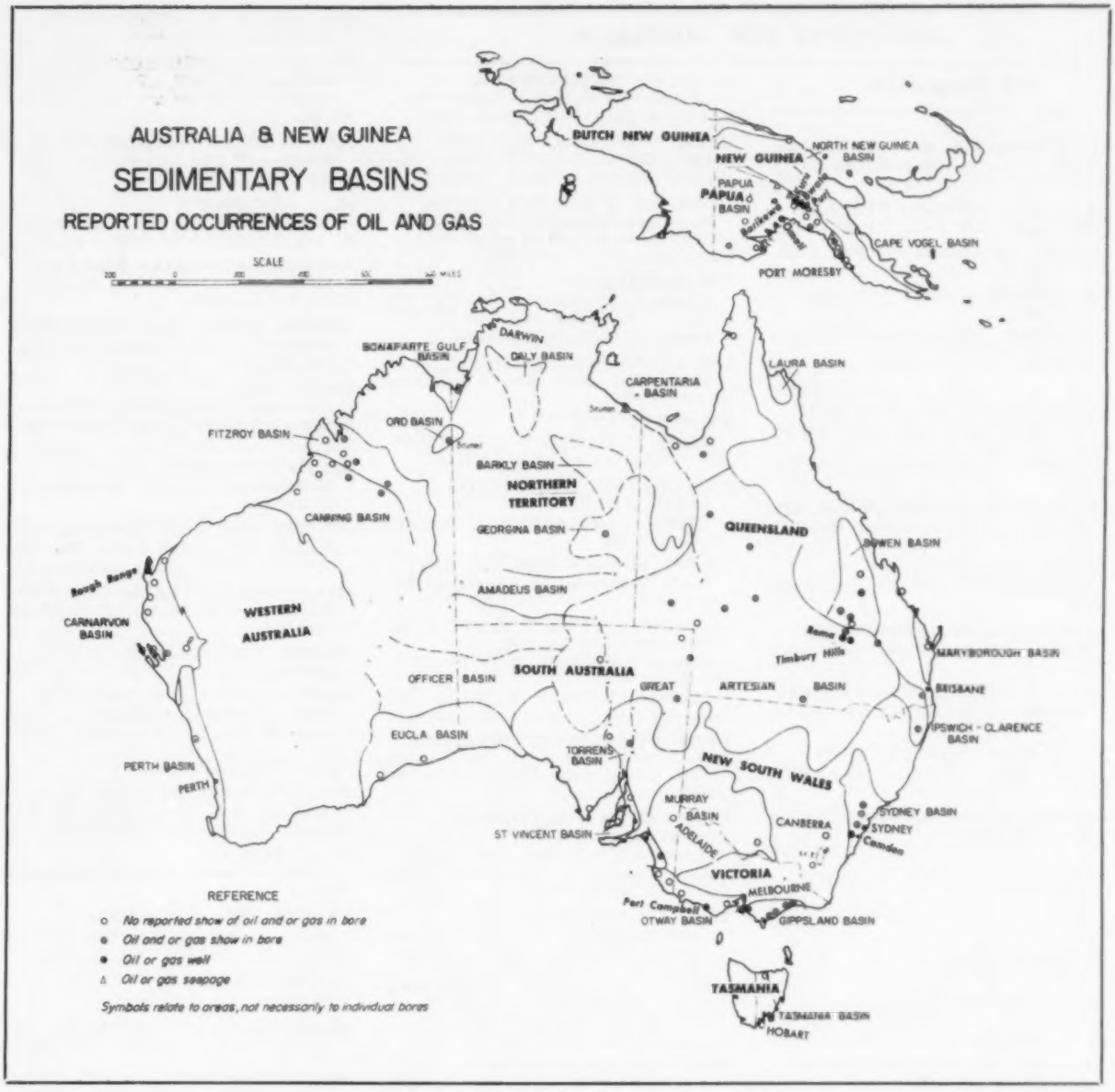
⇧ FOLD ON THIS LINE

Use this envelope to begin your subscription to the Edition of

THE PETROLEUM Engineer

edited expressly for you!

FOLD ON THIS LINE ⇧



kote resins unit connected with the Clyde refinery. Planned expansion of petrochemicals here include an ethylene plant of 25,000 T/yr by Shell to be completed in 1962.

Imperial Chemical Industries of Australia and New Zealand Ltd. (Shell Chemical-Icianz) has announced a polyethylene plant to be built at nearby Botany, New South Wales. It is expected to be completed in 1963.

4. Standard-Vacuum Refining (Australia) has a 42,300 b/cd plant at Altona, Victoria. Units include: catalytic cracking 23,500 b/cd; hydrofining 8500 b/cd; catalytic reforming 6000 b/cd; alkylation 1600 b/cd, and bitumen lubricating oil units.

Australian Carbon Black, has a 11,000 T/yr carbon black plant associated with the Stanvac Altona refinery. In 1961 four new petrochemical units will be completed; Vacuum Oil's planned expansion of petrochemicals associated with the above refinery; 20,000 T/yr ethylene and butadiene; petrochemical unit; Australian Synthetic Rubber's 30,000 T/yr synthetic rubber plant; a styrene monomer, ethylene dichloride unit of Dow Chemical International in association with Colonial Sugar Refining Chemicals; and a polyethylene of 15 million lb/yr capacity of Union Carbide Australia Ltd.

5. Austrialian Oil Refining (Caltex

Turn to page E-15.

TABLE 4. Australian Consumption

	1956	1957	1958	1959	1960
Consumption Inc. refinery fuel b/d avg.	178,250	185,975	195,266	205,867	
Imports crude b/d avg.	161,041	179,694	201,814	202,533	
Imports refined products b/d avg.	40,362	24,614	27,985	32,620	
Annual exports (products) b/d avg.	14,989	17,610	28,100	21,324	

Oil Operators

APPALOOSA OIL OF AUSTRALIA
Sydney: C/- Allen, Allen & Hemsley, 53 Martin Place.

A.P.M. DEVELOPMENT PTY. LTD.
Melbourne: POB 1643. Tel: FY0211.

ARTESIAN BASIN OIL CO. PTY. LTD.
Brisbane: Box 1555V. GPO. Tel: 22919.

ASSOCIATED AUSTRALIAN OIL-FIELDS N.L.
Melbourne: Collins House, 360 Collins Street, Tel: MU7441.
Brisbane: Agent, 31 Charlotte St. Tel: 21366.

ASS'D FRENEY OIL FIELDS N. L.
Melbourne: Collins House, 360 Collins Street. Tel: MU7441.
Brisbane: Agent, 31 Charlotte St. Tel: 21366.

AUSTRALIAN AMERICAN OIL CO.
Brisbane: C/- C. H. Wilson, Box 320, GPO. Tel: B5705.

AUSTRALAMERICA CORP.
Brisbane: C/- C. H. Wilson, Box 320E, GPO.

AUSTRALIAN OIL INDUSTRIES
Perth: C/-Keall, McCall & Brisden, 29 Barrack St.

AUSTRALIAN PACIFIC OIL CO. PTY.
Adelaide: C/-Skipper, Thomas & Linn 33 Pirie St.

AUSTRALIAN PETROLEUM CO.
Melbourne: 37 Queen St. Tel: 61-3821. Cable Code: "AIRVOS".

AUSTRALIAN OIL AND GAS CORPORATION LTD.
Sydney: 44 Martin Place. Tel: BW7644.

AUSTRALIAN PAPER MANUFACTURES LTD.
South Melbourne: Aikman St. Tel: 62-0171.

BUILDERS INC. PTY. LTD.
Sydney: 52 Pitt St.

BROKEN HILL PTY. CO. LTD.
Melbourne: 500 Bourke St. Tel: 67-8001 — 67-8521.

CAMELOT NOMINEES PTY. LTD.
Sydney: 16 Hunter St.

CARPENTARIA OILS PTY. LTD.
Brisbane: C/- C. H. Wilson, Box 320E, GPO. Tel: B5705.

CENTRAL QUEENLAND PET. CO.
Brisbane: C/- R. F. G. Wilson, Box 1555V, GPO.

CLARENCE RIVER BASIN OIL EXPLORATION CO. N.L.
Sydney: 8 Spring St. Tel: BU6871. Cable Code: "SEEARBE"

CONDAMINE OIL LTD.
Brisbane: Box 761K, GPO. Tel: 23121.

CONORADA PETROLEUM CORP.
Brisbane: 74 Seventh Ave., St. Lucia.

CONSOLIDATED OIL PTY. LTD.
Adelaide: Room 313 Churchill Bldg., 61 Gawler Place. Tel: W5931.

CONTINENTAL OIL & GAS LTD.
Adelaide: 68 Grenfell St. Tel: W7088.

CORDILLERA - AUSTRALIAN PET. CO. PTY. LTD.
Brisbane: C/- C. H. Wilson, Box 320E GPO.

DAVIS, DAVID WEWELLYN
Climatis: Three Springs Jersey Stud. Wellington Road. Tel: Emerold 118D.

DELHI AUSTRALIAN PET. LTD.
Adelaide: Box 1837P GPO. Tel: W4812. Cable Code: "DELAUSPET"

DOME OIL & MINERALS SYND.
Melbourne: Temple Court, 7th Floor, 422 Collins St. Tel: MU4136, MU4812. Cable Code: "ELSEECOOKE"

J. G. DONALDSON
Sydney: C/- Builders Inc. Pty. Ltd., 52 Pitt St.
Junee: C. J. Ellis, 10 George St.

LEE EVANS AUST. PETROLEUM
Sydney: C/- Allen, Allen & Hemsley, 53 Martin Place.

EXOIL PTY. LTD.
Sydney: 82 Elizabeth St. Tel: BW2074. BW2075. Cable Code: "OILDRILL"

EXPLORATION DRILLING OF AUSTRALIA LTD.
Sydney: C/- Allen, Allen & Hemsley, 53 Martin Place.

FROME BROKEN HILL CO. PTY.
North Melbourne: 53 Flemington Rd. Tel: FY4011.

FLAMINGO PETROLEUM PTY. LTD.
Melbourne: 128 Queen St.
Sydney: J. G. Fuller, 26 O'Connel St. Tel: BL1300.
Maroubra Beach: P. E. Gauld, 297 Fitzgerald Ave.

GEOSURVEYS OF AUSTRALIA LTD.
Adelaide: Da Costa Bldg., 68 Grenfell St. Tel: W7088. Cable Code: "GEOSURVEYS"

GENERAL EXPLORATION OF AUSTRALIA LTD.
Adelaide: C/- Geosurveys of Australia Ltd., 68 Grenfell St. Tel: W7088. Cable Code: "GEOSURVEYS"

GULF OIL SYNDICATE
Perth: C/- Goyne Miller & Co., West Australian Chambers, 104 St. George's Terrace. Tel: BF3958 — BF3959.
Sydney: E. Gulliver, 17 Sutherland Crescent, Darling Point. Tel: FB2691.
Sydney: B. C. Hancox, Builders Incorporated Pty. Ltd., 52 Pitt St.

HACKATHORN OILS LTD.
Adelaide: C/-Messers. Knox & Hargrave, 112 King William St.

HARVER CORPORATION LTD.
Sydney: 399 George Street.

HAWKESTONE OIL CO. LTD.
Perth: Room 8, 3rd Floor, W. A. Trustee Buildings, 135 St. George's Terrace.

HUMBER BARRIER REEF OILS PTY.
Brisbane: C/- Tully and Wilson, ESA Bank Chambers, 62 Creek St.
Calgary: 708 7th Avenue West.

HUNT OIL CO.
Perth: C/- Keall, McCall & Brisden, 29 Barrack St.

ISLAND EXPLORATION CO. PTY.
Melbourne: 37 Queen St. Tel: 61-3821.

JACKSON EXPLORATION
Perth: C/- H. T. Stables, Solicitors, 9 Barrack St.

KAN-A-TEXO OIL & GAS INC.
Brisbane: C/- C. H. Wilson, Box 320E, GPO. Tel: FA1391.

LONGREACH OIL LTD.
Sydney: 5 O'Connel St. Tel: BL1861. Cable Code: "PRELARMOR"

MACHINERY INVESTMENTS PTY.
Melbourne: 118 Queen St.

MAGELLAN PETROLEUM CORP.
Brisbane: Box 445F, GPO.
Sydney: Ian McFarlane, 1315 O'Connel St.

MINES ADMINISTRATION PTY.
Brisbane: 31 Charlotte St. Tel: 21366. Cable Code: "MINAD"

M. A. MORANDINI
Sydney: C/-L. B. Feeney. 16 Barrack St. Tel: BX-3465 — BX-6018.

NORTEX AUSTRALIAN OILS LTD.
Brisbane: C/- C. H. Wilson, Box 320E, GPO. Tel: FA1391.

NORTH AUSTRALIAN PETROLEUM
Sydney: C/- Allen, Allen & Hemsley, 53 Martin Place.

OILCO LTD.
Melbourne: Ampol House, 792 Elizabeth St. Tel: FJ6093. Cable Code: "OILCO"

OIL DEVELOPMENT N.L.
Melbourne: 11th Floor, 100 Collins St. Tel: MF6321.

OIL DRILLING AND EXPLORATION
Sydney: 82 Elizabeth St. Tel: BW2074 — BW2075. Cable Code: "OILDRILL"

OVERLAND AUSTRALIA OILS LTD.
Sydney: C/- Allen, Allen & Hemsley, 53 Martin Place.

PACIFIC AMERICAN OIL CO.
Brisbane: Box 1555V, GPO. Tel: 22919.

PAPUAN APINAIPI PETROLEUM
Sydney: Pendennis Chambers, 375 George St. Tel: BX7563, BX4900, BX-4909.
Cable Code: "PAPAPIN"

PHILLIPS PETROLEUM CO.
Brisbane: Box 863L, GPO. Tel: 31-2645/46. Cable Code: "PHILAUST"

PLACID OIL CO.
Perth: C/- Keall, McCall & Brisden, 29 Barrack St.

PLANET EXPLORATION CO.
Sydney: 26 O'Connel St. Tel: 25-1300. Cable Code: "JAYFUL"

PLYMOUTH OIL CO.
Brisbane: Box 320E, GPO.

QUEENSLAND AMERICAN OIL CO.
Brisbane: Box 1555V, GPO. Tel: 22919.

J. C. REYNOLDS
Elizabeth Bay: 3 Ithaca Flats, Ithaca Road.

RIO TINTO (AUST.) EXPLORATION
Melbourne: 408 Collins St. Tel: MY-1951.

SANTOS LTD.
Adelaide: Mutual Life Chambers, 44 Grenfell St. Tel: W6521. Cable Code: "SECOFFICE"

SEISMIC ANALYSIS INC.
Houston, Texas, U.S.A.: 1121 Texas Bank Bldg.

L. H. SMART OIL, EXPLORATION
Sydney: 16-20 Bridge St., Tel: BU1311. Cable Code: "SMARTSYD"

SMITH AUSTRALIAN OIL CO. N.L.
Darwin: C/- Newell & Ward, Kanckey St.

STANDARD GAS PTY. LTD.
Brisbane: 307 Queen St.

STERLING AUSTRALIAN OIL CORP.
Sydney: C/- Allen, Allen & Hemsley, 53 Martin Place.

J. STREVENS, R. WALTON & MR. CLARENSHAW
Sydney: C/- 95 Military Road, Neutral Bay.

SUNRAY MID-CONTINENT OIL CO.
Brisbane: Box 863L, GPO.

TEXAS AMERICAN OIL CO.
Sydney: C/- Allen, Allen & Hemsley, 53 Martin Place.

TEXTRALIAN OILS PTY. LTD.
Perth: 1st Floor, 39 Barrack Street.

THREE STATES AUST. PET. LTD.
Darwin: C/- Newell & Ward, Kanckey St.
Sydney: C/-A. S. Bingle, GPO 3958.

TRITON CORP.
Port Moresby: C/- J. I. Cromie, Cnr., Douglas & Cuthbertson Sts.
Brisbane—Box 320 E GPO.

UNION OIL DEVELOPMENT CORP.
Sydney: Kern County Land Co., Box 5048, GPO.

VICTORIAN OIL N.L.
Melbourne: Collins House, 360 Collins St. Tel: MU6851.
Sydney: Roland Walton, 56 Pitt St.
W. C. Walz & H. J. Walz, Marian, Via Mackay, Q'LD.

WEST AUSTRALIAN PETROLEUM
Perth: 251 Adelaide Terrace: Tel: BF-3941. Cable Code: "WAPET"

WESTRALIAN OIL LTD.
West Perth: 44 Parliament Place. Tel: BA9225. Cable Code: "WESTOIL"
R. B. Withers. See Woodside (Lakes Entrance) Oil Co. N.L.

WINDFALL OIL & MINES LTD.
Darwin: Newell & Ward, Kanckey St.
Toronto: 217 Bay Street.
Coolangatta: Andrew J. Wood, GPO 55.

WOODSIDE (Lakes Entrance) OIL CO. N.L.
Melbourne: Ampol House, 792 Elizabeth St. Tel: FJ16093. Cable: "OILCO"

State and Territory Mines Departments

NEW SOUTH WALES
Sydney: The Under Secretary, Dept. of Mines, GPO Box 48. Tel: BU-7361.

WESTERN AUSTRALIA
Perth: The Under Secretary for Mines, Mines Dept., Central Government Bldgs. Tel: BF0151.

SOUTH AUSTRALIA
Adelaide: The Director of Mines, Department of Mines, Box 38, Rundle St., PO. Tel: W0461. Cable Code: "DOMEX"

VICTORIA
Melbourne: The Secretary for Mines, Department of Mines, Treasury Gardens. Tel: MFO321.

TASMANIA
Hobart: The Director of Mines, Dept. of Mines, POB 177E. Tel: B4041.

QUEENSLAND
Brisbane: The Under Secretary, Department of Development and Mines, Treasury Bldg. Tel: B5434.

NORTHERN TERRITORY
Darwin: The Director of Mines, Northern Territory Administration. Tel: 591. Cable Code: "DIRECMIN"

TERRITORY OF PAPUA, NEW GUINEA
Port Moresby: The Secretary, Department of Lands, Surveys and Mines.

Supply and Service Companies

American Iron & Machine (rotary drilling equipment).
Dist:* Mindrill Ltd.
Melbourne, Victoria: 86-106 Plenty Road, Preston, N. 18. Mgr: P. J. Kirkwood.

Ampol Petroleum Ltd. ("Jet-Lube" anti-seize thread compounds for drill collars, tool joints, casing and tubing; oilfield lubrication and specialities).
Sydney, N.S.W.: Buchanan St., Balmain, POB† 5342. Tel: WB-0233. Cable: AMPOLCO. Mgr: W. M. Leonard.

Austral Geo. Prospectors Pty. Ltd.
Brisbane, Queensland: POB 251, Fortitude Valley.

Baker Oil Tools (sales & technical advice).
Dist: J. Bayliss Inc.
Brisbane, Queensland: POB 387E. Cable: JAYBAYLISS. Mgr: James Bayliss.

Beryllium Corp. (beryllium copper safety tools, rod, strip, casting alloys and castings).
Dist: Investo Mfg. Co.
Sydney, N.S.W.: 134 Military Road, Neutral Bay. Tel: XY 5602, XY 1821. Cable: INVESTO. Mgr: Roy C. Underwood.

Bowen Itco Inc. (fishing tools, oilfield specialty tools, wire line tools).
Dist: Bayliss Inc.
Brisbane: POB 387E. Cable: JAYBAYLISS.

Branson Inst. (ultrasonic cleaning, gaging and flaw detection equipment).
Dist: A. A. Guthrie Pty. Ltd.
Marrickville, New South Wales: 16-18 Meeks Road.

Bucyrus-Erie (sales and service).
Dist: Harris, Scarfe & Sandovers Ltd.
Perth: Hay Street, POB B-92. Tel: Perth B. F. 0131. Cable: HARRISAND.
Dist: Ruston & Hornsby (Aust.) Pty. Ltd.
Clayton, Victoria: Dandenong Road, Box 1, POB 135. Tel: 744-2481. Cable: RUSTONS. Mgr. Dir: R. T. Crossley.
Artarmon, N.S.W.: 99 Reserve Road, POB 3. Tel: JR 3114. Cable: RUSTONS.
Brisbane, Queensland: 83 Albert St., POB 366-E. Cable: RUSTONS. Tel: FA 1944.
Adelaide: 198 Flinders Street, Corner Ackland. Tel: W 1432. Cable: RUSTONS.

Cabot Corp. (pumping units, drilling, well servicing, etc.)
Dist: N. G. Clark (Machinery) Pty.
Melbourne: 143-145 Latrobe St. POB 1504, N. Melbourne. Tel: FB 3112. Cable: DIKEMALS. Mgr: Norman K. Clark.

Cardwell Mfg. Co. (servicing, workover and drilling units).
Dist: Joy Mfg. Co. Pty., Ltd.
Roseberry, N.S.W.: 56-58 Rothschild Ave. POB 63. Tel: FF 4163, FF 3512.

Carrier Inter'l Ltd. (air conditioning, heating, refrigeration).
Dist: Carrier Air Conditioning Pty. Ltd.
Sydney: 36-40 Bourke St., POB 151. Tel: FL 3211. Cable: MANUWETHER. Mgr: A. R. Morris.
Melbourne: Friars Road, Moorabbin, POB 79 Moorabbin, S.20. Tel: XL 3671-6. Cable: MANUWETHER. Mgr. Frank C. Pearson.
Brisbane: 26-28 Annerley Road. Tel: B 1391. Cable: MANUWETHER. Mgr: J. A. Murphy.
Adelaide: 262 Brighton Road, Somerton Park. Cable: MANUWETHER.

Chicago Bridge & Iron Co. (oil storage tanks, evaporation saving equipment, refinery vessels, steel construction).
Dist: Bernard-Smith (Pty.) Ltd.
Sydney: Maddox St. Cable: BERSMITH-STEEL.
Dist: Deakin, Evans & Co.
Sydney: Eagle & Charlotte Sts. Cable: DEVAN.

Chiksan Intern'l (swivel joints, tank and truck car loading arms, and Weco unions).
Dist: J. Bayliss Inc. Pty. Ltd.
Brisbane: 337 Queen St. POB 387E. Tel: JW 3666. Cable: JAYBAYLISS. Mgr: J. Bayliss.

Continental-Emsco (drilling and production equipment).
Dist: Gilbert Lodge & Co., Ltd.
Sydney: POB 2546. Tel: MW 2222, 2848, 3058, 3411, 3412, 3413. Cable: GILBERTLOJ. Mgr. Dir: Foster S. Martin.
Adelaide: 154 West Terrace, POB 848. Cable: GILBERTLOJ. Mgr: Alex Thomson.
Melbourne: POB 40. Dir: I. H. Lowen.
Newcastle: 237 Denison St. POB 11, Broadmeadow, NSW. Mgr: G. W. Birrell.
Brisbane: Scottish Union House, 127 Eagle St. POB 600-J. Mgr: Reginald C. Robinson.
Perth: 340 Hay St., POB 15, Subiaco. Mgr: J. F. McLeod.

Crane Carrier Corp. (construction equipment vehicles).
Dist: C.C.C. Carriers Pty. Ltd.
Sydney: 50 Miller Street, POB 288, Nth. Sydney. Tel: XB 9082. Cable: CRANECAR. Mgr: C. S. J. Johnson.

Curtiss-Wright (stainless steel and alloy steel extruded pipe; engines, simulators, propellers).
Dist: Welding Distributors Pty. Ltd. (steel etc.)
Dulwich Hill, N.S.W.: 382 New Canterbury Road. Tel: LM 1334. Cable: WELDISTERS. Dir: W. Bernard.
Dist: E. L. Heymanson & Co. Pty. Ltd. (engines etc.)
Melbourne: Elizabeth St., POB 5226 BB. Tel: MU 8571/2. Cable: AUSEMFOR. Exec. Dir: Geoffrey D. Nicoll.

Detrick, M. H., Co. (refractory arch and wall heat enclosures for furnaces, etc.)
Dist: M. H. Detrick (Aust) Pty. Ltd.
Sydney: Caltext House, 167-187 Kent St. N.S.W. Tel: BU 4930. Cable: DETRICAUST. Mgr: H. G. Thornthwaite.

Dresser Mfg. Div. — Dresser Industries (pipe couplings, clamps and repair sleeves)
Dist: Malco Industries Ltd.
Marrickville: Rich St. Tel: LM 0141. Cable: MALCOIND. Mgr: C. S. Lovell.

*Distributor.
†Post Office Box.

Failing, George F. Co. (drilling rigs).
Dist: Tutt-Bryant, Ltd.
Rydalmere: N.W.S. South St. Cable: LEOTUTT.

Gardner Denver Co., (Australia) Pty. Ltd.
Artarmors, N.S.W.: 70 Hatham Parade.

Geophysical Services Inc. (seismic, gravity and magnetic surveys and seismic data processing service).
Perth: 193 Williams St., POB S 1305. Tel: VW 1652. Cable: GEESYE. Mgr: E. J. Malovich.

Hercules Motors (gasoline and diesel engines, gasoline engines).
Dist: Perkins Steel & Engineering Pty.
Sydney: A.N.I. Bldg., Birnie Ave., POB 2630.
Lidcombe: 16 Parramatta Road, POB 117.
Melbourne: Capel & Queensberry Sts., POB Box 4571.
Brisbane: 324 Wickham St., POB 113 Fortitude Valley.
Alberton: 138 Port Road, POB 17.
Rivervale: 265-269 Great Eastern Highway, POB 7.

Hughes "Seisblaat" Bits Commercial Enterprises
Brisbane, Queensland: POB 1990

Johns-Manville (all export building materials except floor tile and backline products; celite filter aids and fillers).
Dist: Roof and Building Service. (bldg. mat'ls etc.)
Brisbane: 16 Garrick Terrace, Herston. Cable: ROOFSERCO.
Dist: Eliza Tinsley Ltd. (aids & fillers).
Melbourne: 640-652 Bourke St., POB 4327. Tel: MU 6531. Cable: IRONMASTER.
Dist: Hugh Wasson & Co. (bldg. mat'ls etc.)
Kent Town: 39 Rundle St.

Lane Wells Dist: Oil Drilling and Exploration Ltd.
Sydney, N.S.W.: 93 York St.

Lummus Co. of the Hague (heat exchangers) Dist: Bernard-Smith (Pty.) Ltd.
Sydney: 15-33 Maddox St., POB 72. Tel: LA 5026. Cable: BERSMITH-STEEL. Mgr: A. Gluckman.

Mack Trucks (motor trucks, replacement parts and service repairs).
Dist: Champions Ltd.
Adelaide: 113-119 Currie St. Tel: LA 2292. Cable: CHAMPMOTOR.
Dist: Antill Ranger & Co. Pty. Ltd.
Alexandria, N.S.W.: 2-14 Bourke Road. Tel: MX 5365. Cable: HAULANT-SYDNEY.
Dist: Andersons Agencies Pty. Ltd.
Brisbane: 122 Margaret St. Tel: 312291. Cable: ANDGEN.
Dist: Moore Road Machinery (W.A.)
Perth: POB 1602. Tel: MJ 1111. Cable: EARTHMOVE.
Dist: Frank B. Paul.
Sydney: POB 4418. Tel: FM 5651. Cable: LUAP.

Magnetrol (magnetrols).
Dist: Electric Equipment of Australia.
Crows Nest, N.S.W.: POB 29.

Marley Co. (water cooling equipment).
Dist: R. Werner & Co. Pty. Ltd.
Richmond, Victoria: 54-86 Burnley St. Tel: JB 3711. Cable: WERNERCO (Melbourne). Mgr: Len Clough.

Mid-Continent Supply Co. Dist: E. Ling and Co.
Adelaide, S.A.: 44 Grenfell St.

Mines Administration Pty. Ltd. (exploration and drilling contractors).
Brisbane, Queensland: 31 Charlotte St.

Mission Mfg. Co. (slush pump valves & pistons, piston rods, swabs, etc.)
Dist: Oilfield Supply Pty. Ltd.
Sydney: 93 York St. Tel: BX 7961. Cable: OILDRIL-SYDNEY. Mgr. John G. Antliff.
Dist: Tomlinson Steel Ltd.
Perth: POB P 1223. Tel: 6-2055. Cable: TOMLINSONS' PERTH. Mgr. Dir: Ernest E. Tomlinson.

National Supply Co. (oilfield supplies).
Dist: Tutt-Bryant, Ltd.
Rydalmere, N.S.W.: South Street. Cable: LEOTUTT, Sydney.

Oil Drilling and Exploration Ltd.
Sydney, N.S.W.: 93 York St.

Reed Roller Bit Co. Dist: Tutt Bryant Ltd.
Rydalmere, N.S.W.

Schlumberger Overseas, S. A. (electric logging and perforating).
Dist: Schlumberger Seaco, Inc.
Brisbane: Podesta House, 15-23 Evelyn St., POB 289, Valley. Tel: 52 169. Cable: SCHLUMBERGER BRISBANE. Mgr: Jean Renie.

Security Inter'l—Dresser Industries (oil, gas, chemical equipment).
Dist: Oilfield Supply Pty. Ltd.
Sydney: 93 York St.

Seismic Supplies (Australia) Pty. Ltd.
Brisbane, Queensland: 444 Brunswick St., Valley.

OIL / GAS
WATER
PRODUCTS
PIPELINE SYSTEMS

WILLIAMS BROTHERS

ENGINEERS - CONSTRUCTORS

NBT BUILDING, TULSA, OKLAHOMA / CABLE: WILLBRO

NEW YORK / WASHINGTON / LOUISVILLE
MINNEAPOLIS / CARACAS / BOGOTA / LA PAZ / EDMONTON
CALGARY / LONDON / ANKARA / TEHRAN

THE
Hotel in the
Oil Capital
of the World

100%
Airconditioned
600 Bright *Reasonably* Priced Rooms

THE MAYO

TULSA'S *Finest* HOTEL
Sample Rooms – Finest Food
Adjacent Garage

Southwestern Industrial Electronics — Dresser Industries (seismograph equipment).
Dist: Austronic Engineering Labs.
Melbourne: 420 William St.

Tomlinson Steel Ltd. (mfg. engrs. "Cleaver Brooks" boilers, refinery pressure vessels and tankage, railway rolling stock).
Perth: Planet St., Carlisle, POB P 1223. Tel: 6-2055. Cable address: Tomlinsons, Perth. Mgr: F. H. Dorney.

Tracerlab, Inc. (radiation detection equipment, radioactive chemicals, nuclear instrumentation, consulting service, isotope applications).
Dist: A. A. Guthrie Pty. Ltd.
Sydney: 5 Blight St.

Tulsa Products Div. — Vickers Inc. (winches, power take-offs, speed reducers, transmissions).
Dist: Vickers-Detroit Hydraulics Pty. Ltd.
Maribyrnong, Victoria: Rosamond Road.

United Geophysical Co. S.A.
Melbourne, Victoria: 468 Lt. Collins St. Mgr: H. D. Gray.

Williamson, T. D. Inc. (tapping machines, stopples, pigs, casing seals, insulators).
Dist: Austral Eng. Supplies, Pty. Ltd.
Sydney, N.S.W.: 490-494 Kent St. Tel: BM 2195. Assoc. Dir: A. E. Sherrell.
Brisbane, Queensland: 475 Adelaide St.
Windsor S. 1, Victoria: 44 Punt Road.

AUSTRALIA

Continued from page E-11.

affiliate) has a 46,000 b/sd plant at Kurnell, New South Wales. Units are: Catalytic cracking 24,500 b/sd; polymerization unit 2700 b/sd; and propane deasphalting unit 9500 b/sd.

The company expects to virtually double capacity with these additions: Crude capacity, 45,000 b/sd; alkylation unit, 3400 b/sd; and catalytic cracking, 18,000 b/sd. Completion is scheduled for 1961.

A new lubricating oil refinery of 2700 b/d capacity is planned for Kurnell by Caltex (50%) H. C. Sleigh (25%) and Ampol Petroleum (25%). This should be ready for operation in 1963.

6. Bitumen and Oil Refineries (Australia) has a refinery at Matraville, New South Wales of 15,000 b/sd crude capacity; catalytic reforming, 4600 b/sd; hydrodesulfurizer 4600 b/sd, and a bitumen plant.

Planned expansion will add a new $5 million 4500 b/sd fluid catalytic cracker to the refinery by the end of 1961.

Commercial Solvents Pty. Ltd. will complete a solvents plant this year which will be operated by Bitumen and Oil Refineries.

Monsanto with Petroleum and Chemical Corporation of Australia Ltd. is constructing a styrene plant in connection with the Matraville refinery at Silverwater.

7. Bitumen and Oil Refineries (Australia) has a plant at Hamilton, Queensland with capacity of 2000 b/sd prepared feed stock and a bitumen plant. It is operated by Queensland Oil Refineries Pty. Ltd.

8. Vacuum Oil Company Pty. Ltd. is building a new $36 million refinery at Port Noarlunga, South Australia. It will have a 30,000 b/cd crude capacity and a catalytic reformer.

Ampol, an Australian company, is considering building a $34 million refinery at Port Alma, 40 miles southeast of Rockhampton; this would be the first in the state of Queensland and would give Australia a refinery in every mainland state.

Amoco Australia Ltd. (Standard Indiana) plans a 15,000 b/d refinery near Brisbane.

Refineries in Australia processed 217,000 b/d in the year ending June 30, 1960. This is 11% more than in the previous year. Exports of refined products amounted to 26,000 b/d (mainly black oils to New Zealand, Singapore, Argentina and Aden), and 27,000 b/d of products were imported. ★ ★ ★

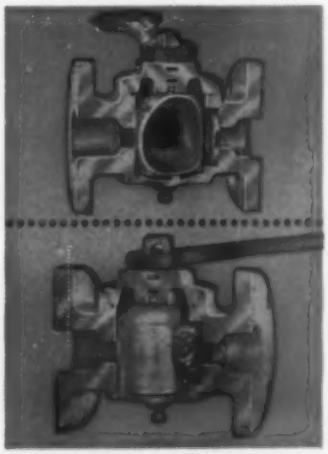
WHY BUY 2 ? . . . WHEN 1 WILL DO!

ONE FRANK WHEATLEY PLUGAROO!

Get TWO-IN-ONE for the Price of ONE!

- The Plugaroo is a combination non-lubricated plug and check valve!
- The plugaroo completely eliminates the need of one valve!
- Save 50% by buying the PLUGAROO!
- Over 20,000 now in use!
- Available in sizes 1" to 36"; full or regular opening!
- Example: Factory shipment price for 2" screwed ends — only $10.39.
- Send for descriptive literature or see pages 5634 and 5635 in Composite Catalog.

Why buy two valves, when one non-lubricated PLUGAROO combination plug and check valve . . . will do the job better and cheaper? As a check, the clapper-hinged on a 20° angle . . . seals under its own weight. As a plug, a quarter turn gives a positive seal without galling or scoring plug, clapper, or valve body. Available with Teflon or Synthetic Rubber seals in steel, semi-steel, or aluminum bronze from Series 15 to 90. Full opening sizes 1" to 36" in all API, ASA dimensions and end connections. Write for further details.



Cut-away illustrates **PLUGAROO** with plug "closed" (top) and as check valve "open" (bottom).

SINCE 1916

FRANK WHEATLEY
PUMPS & VALVES
TULSA, OKLAHOMA

P. O. BOX 1948 • LU 4-5175
TULSA, OKLAHOMA

ALSO NEW . . . the SLAM-MINIMIZER CHECK VALVE for high pressure gas lines . . . and the new SPHERE-CLEAR CHECK VALVE for lines using ball-markers for interface and batch change.

SEE OUR CATALOG IN COMPOSITE CATALOG

YOUR SUPPLY STORE SHOULD HAVE THEM!

Practical Experience plus Engineering Skill...

DYNEL, inc.

CUSTOM-BUILT CONTROL & TELEMETERING SYSTEMS

for

- REFINERY
- PIPE LINE
- GAS TRANSMISSION

Specializing in telemetering control and data handling... logging associated with liquid level, temperature, pressure and flow.

Dynel, Inc., is prepared to take acceptance of system responsibility.

Consult us on your difficult problems in instrumentation.

DYNEL, inc.

1401 S. Alameda Street
Compton, California

A manufacturing enterprise

HOW GOOD IS YOUR GUARD?

JOHN HINDS

The guard at the gate, the office receptionist, the PBX operator and your secretary, all have *your* foot forward. Is it *your* best one?

They are the people who first see those who call to see you or some member of your firm. They make that first impression; the most important one that is ever made.

Quite often, largely due to the attitude of management or the boss, the workers become officious, militaristic protectors (of what no one really seems to know) instead of being persons who graciously receive visitors and callers.

It is true, that the gate guards at our large industrial plants and warehouse installations are there for protective reasons, to keep unauthorized persons from entering the premises, both from the standpoint of protecting the interests of business as well as the safety and well being of the individual visitor. The guard at the gate, wearing a uniform, a badge and sometimes a gun, often becomes some sort of duty-bound policeman who attempts to demand respect instead of attempting to win respect by efficient and courteous demeanor.

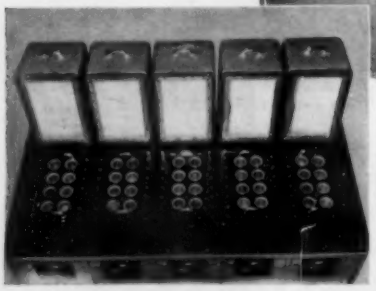
The same is often true of receptionists and PBX operators. True, the receiving of many visitors and callers in the course of a day can be a most irritating job. Many callers do not understand why they can not immediately talk to the person they wish to see and most people dislike waiting. However, a few courteous and well-chosen words on the part of the receptionist can often take the sting out of what otherwise

Mr. Hinds is director of public relations for Texas Manufacturer's Association. This good piece of warning was first published in *Texas Industry*, TMA's magazine, edited by Opal Hill Munz.

CLOUD and POUR TEST CHAMBER

CONRAD
MODEL CAL-5-1-1
Catalog No. 61201

Self-contained chamber for testing pour point and viscosity of oils to A.S.T.M. Spec. Five individual baths permit testing from ambient to -90°F. within 2°F. control point. Instrumentation optional.



Each bath is 11⅝" long, 6" wide, 10" deep, with cover and 8 cloud and pour sleeves, 1¾" dia. x 4¾" deep. Four-bath and custom designed units available.

Ask your Conrad man for details, or write the main office

CONRAD Inc.

CONRAD, INC.
CONRAD SQUARE • HOLLAND, MICHIGAN
A subsidiary of Crampton Manufacturing Co.

Amot Model 1476 Safety Control

Acts immediately to STOP ENGINE

When oil or control pressure drops below set level, Amot Model 1476 automatically trips and shuts down engine using positive snap-action principle. Tripping pressure adjustable from 5 to 30 p.s.i. For solid fuel or gas engines. Used with other safety devices for complete protection. Compact, non-electrical.

Amot controls
CORPORATION

THERMOSTATS
CONTROLS
SWITCHES VALVES
SAFETY CONTROLS

407C FIRST ST. • RICHMOND, CAL., U.S.A.

might be an irritating experience.

The over-protective secretary is also the source of much irritation to many visitors.

Recently a conversation was overheard at a luncheon table. It went something like this:

"Say Joe, I haven't seen you for six or eight weeks. The last time I saw you, you said you were coming in to see me. I really have something important to discuss with you."

"Well, Mike, I have tried to call on you several times during the past weeks. One day I was in your neighborhood and had a few spare minutes. I stopped by your plant but had so much difficulty getting clearance at the gate I would hardly have had time to talk to you so I decided to leave and make the call another time. Later, I tried to telephone and did get through to your secretary. She insisted on knowing the nature of my business which I thought was no concern of hers. On another attempted visit I was curtly told you were busy and were not receiving calls. I thought about leaving my telephone number but, not getting any encouragement, I decided not to leave it. A few days ago, I did get by the guard at the gate and after a persuasive conversation with the receptionist, I was permitted to see your secretary. She told me you were busy and not receiving callers. So, Mike, I just decided you were too hard to see and that I would wait until you and I had another chance meeting. Suppose we get together this afternoon.

"Incidentally Mike, I hope you don't

SALESMEN WANTED

Sell the hottest piece of transistor equipment direct to the accounts you already call on. Two way Walkie Talkie, pocket size radio, weighs only 18 ounces, range up to 5 miles. Speeds communication in plant and factory. Priced right, big profit on every sale. *Write to:* **Brian Sales Co.,** 161 West 16th Street, New York City 11.

ADVERTISING SALES OR PROMOTION

Trainee for leading oil, gas, petro/chem publications. Must be personable, intelligent, tactfully aggressive. He could be a graduate in advertising, marketing, journalism, or a petroleum, mechanical or chemical engineer presently employed in the oil-gas industry. Writing aptitude important. Excellent opportunity for young man of right qualifications. *Apply by letter and resume to* **P. O. Box 1589, Dallas, Texas,** *sending qualifications, telephone number and photo. Replies will be held in confidence.*

COUPLINGS BY Wheeling

WHEELING MACHINE PRODUCTS CO.

Wheeling, West Virginia

West Coast Factory: Woodlake, California

For Constant, Uninterrupted POWER FLOW in the OIL FIELDS

You'll Never Go Wrong with FIELDMASTER BALL BEARING MOTORS

Here's Why . . .

They are specifically designed to overcome the unusual conditions of Oil Field requirements, and there is a type and H.P. built to fit your exact needs. Unexcelled since they are . . .

- **DRIP PROOF**
- **VERMIN PROOF**
- **MOISTURE PROOF**
- **CORROSION RESISTANT**
- **FORCED AIR COOLED**
- **HAVE SEALED TERMINAL PORT**

SEMI-ENCLOSED — normal or medium slip, 3 phase, 60 cycle. Has prelubricated ball bearings in semi-enclosed protected housing, 40 degree C rise. Built for continuous duty. **High Torque, low starting** current. Extra insulating coating throughout.

TOTALLY ENCLOSED — Fan cooled, normal or medium slip, 3 phase, 60 cycle. Has prelubricated ball bearings, totally enclosed FAN cooled 55 degrees C rise, for continuous duty. High Torque — low starting current. Extra insulating coating throughout.

Write for fully descriptive literature

BETHLEHEM STEEL CO. Supply Division **Tulsa, Oklahoma**

Manufactured by Valley Electric Corporation, St. Louis 8, Mo.

mind. I took your secretary to dinner after meeting her and found she was a lovely girl. She apologized for having been so difficult and hastened to explain that you had made it clear to all concerned some months ago that you had been getting entirely too many visitors and you wanted the traffic slowed down."

By this time, busy Mike's face was a bright hue of crimson, since Joe, an attorney, was one of the original and principal owners of Mike's company.

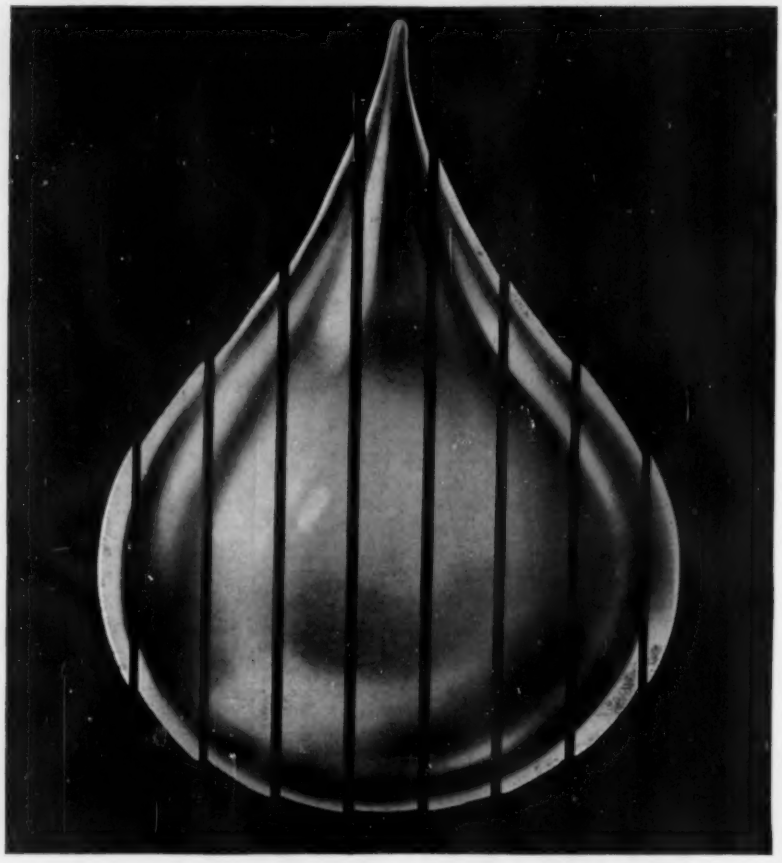
Mike is really a personable fellow but he is also one who gives the appearance to everyone including most of his employees, of being eternally too busy.

The guard, the receptionist, the PBX operator and the secretary all were nice persons who wanted more than anything to do what was right for the boss and to do what he wanted them to do. Instead of encouraging and helping them to put *his* best foot forward, Mike had simply told them to put *his* foot forward and slow down the traffic.

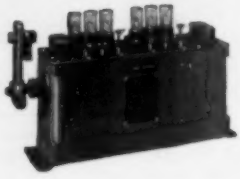
There is a vast difference in stopping the unwanted visitor cold and keeping him out and yet at the same time, making him feel he is welcome to call again.

* * *

HOW THIN can you slice a drop of oil?



Whether you want to deliver several drops or the minutest fraction of a drop per piston stroke, a Manzel lubricator will do the job exactly. Manzel lubricators force oil of any viscosity against the high steam, gas and air pressure so common in modern compressors, engines and machines. They start, stop, speed up or slow down in synchronization with your equipment. Write for our catalog explaining the whole line. Manzel, 255 Babcock Street, Buffalo 10, New York. For efficient lubrication



ask the man from

UNIT OF HOUDAILLE INDUSTRIES, INC.

Manzel

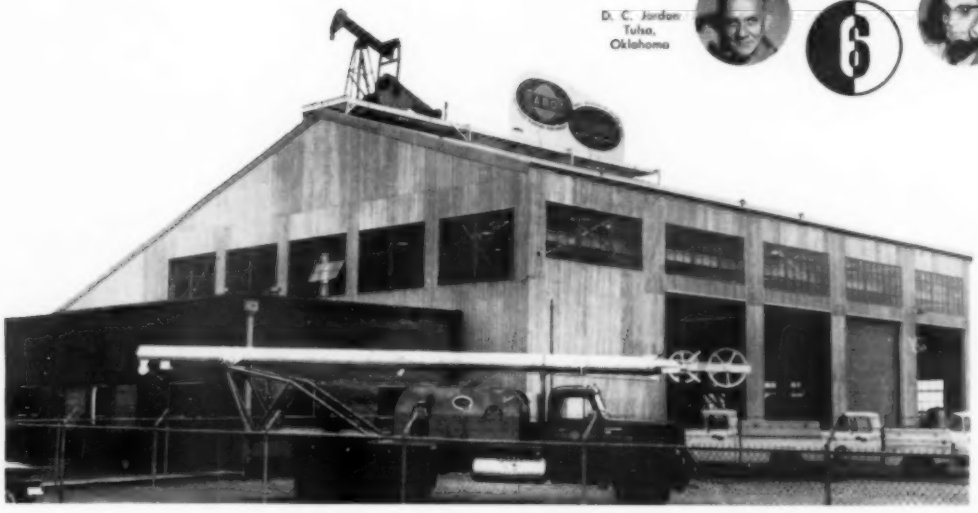
SPECIALISTS IN LUBRICATORS AND METERING PUMPS SINCE 1898

Cuisine Exquise . . . Dans
Une Atmosphère Élegante

575 Park Avenue at 53rd St.
NEW YORK

Lunch and Dinner Reservations
Michel: TEmpleton 8-6490

ODESSA SERVICE CENTER



EVERY CABOT UNIT BACKED BY *'ROUND-THE-CLOCK* FIELD SERVICE

Cabot has earned the title of "First In Service" the hard way . . . *by working hard* at establishing an unexcelled network of first class service centers strategically located throughout the oil country.

Cabot's Odessa Service Center is typical of these installations. Each center carries a complete stock of Cabot parts. Factory trained personnel service your Cabot units according to recommended factory procedures.

Next time try a Cabot . . . and get quality and service that's your 24-hour-a-day guarantee of dependable pumping.

CALL YOUR J&L MAN...

OIL FIELD PUMPING EQUIPMENT
CABOT
PAMPA, TEXAS
FRANKS

CABOT CORPORATION
MACHINERY DIVISION

Today's Discoveries Are Yesterday's Dry Holes

Welex's Simplified Logging Program today logs many discovery wells in areas once called "dry hole" country.

Thanks to modern techniques, such as the Welex program, you can now pinpoint and produce profitably many pay sands, ignored by old-fashioned logging tools a few years ago.

The Welex Simplified Logging Program does this for you ACCURATELY and FAST.

Introduced to eliminate confusion and complicated computations, the Welex program within minutes gives you the answers to the two main questions — WHAT IS THE POROSITY and WHAT IS THE FLUID SATURATION.

Based on only two factors — type of porosity present and drilling mud/formation water salinity contrast — the Welex Simplified Logging Program makes selection of the BEST LOGGING PROGRAM for every well easy, as shown by the diagram here.

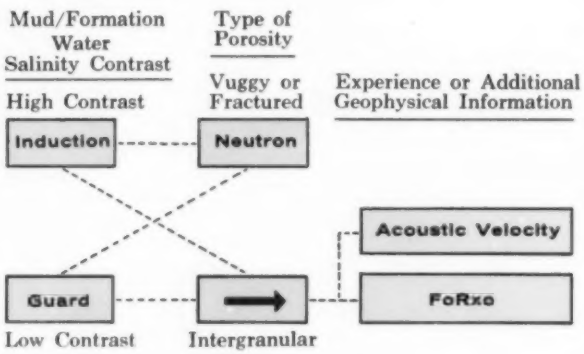
The addition of Welex's Acoustic Velocity Log to the program makes even more information available to you. The Acoustic Velocity Log is the ideal choice when used in:

1. Formations where experience or past performance indicates that its porosity values are more accurate.

2. Areas where velocity data is desired for geophysical purposes.

As with the Welex FoRxo and Neutron Logs, you can read porosity values directly off the Acoustic Velocity Log. When run in conjunction with the Welex Induction or Guard Log, your most important question — WILL THE WELL PRODUCE? — can be answered in minutes by using the Simplified Interpretation Charts or "pigtails" printed right on the log.

The Welex Simplified Logging Program IS THE ANSWER for your well.



COMPLETE WIRELINE Welex SERVICES

WELEX

A Division of Halliburton Company

General Offices: 1728 Old Spanish Trail, Houston, Texas

Of Things To Come . . . In Oil

LOUISIANA ALLOWABLE BOOST will result in expanded wildcatting. An increase in allowable production in the state of 18,400 bbl per day for March and April has put Louisiana in the 1,000,000 bbl-per-day bracket. Producers are also expected to benefit from trend established by recent gas-in-place purchases.

OCEAN-FLOOR WELL COMPLETIONS are in for more attention and development by several major producers. Cities Service and Richfield set the pace in California offshore waters and off the coast of Peru. Shell has own version under tight wraps, but announcement was made recently of its Louisiana offshore installation. Others are looking at method to get an operating head start when bids may open for Federal leases in deeper Gulf of Mexico waters.

FUELS STUDY IS NO OIL THREAT, says Alvin C. Hope, IPAA president, at San Antonio, Texas, meeting. House resolution "contains no language which could be construed as a threat to sound oil, gas, or energy policies," said Hope.

CHEAP SOURCE OF MAKEUP GAS for gas lift is soon to become available. Small, skid-mounted inert gas generator takes compressor engine exhaust gases and produces 88% nitrogen, 12% carbon dioxide at about 3 cents per Mcf. Enlarged unit can produce 99.8% pure nitrogen. Field tests are now underway; other field uses are in the offing. Nergas Corporation of Lafayette, Louisiana, holds the patents.

TEXAS COURTS WILL HEAR TRESPASS CASES growing out of fracturing of oil and gas reservoirs, reserving jurisdiction from state's Railroad Commission. Recent Texas Supreme Court ruling grew out of suits brought by Delhi-Taylor to prevent owners of small tracts adjoining Delhi-Taylor leases from fracturing their wells, claiming that resulting fractures would invade its reserves. Supreme Court ruled that question is basically one of trespass and is therefore subject to settlement by judicial bodies.

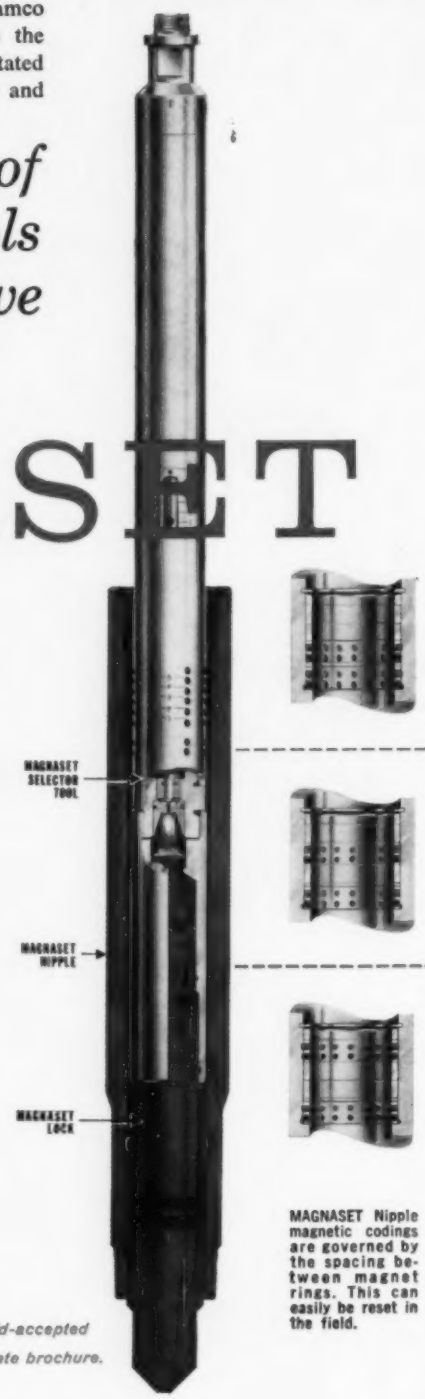
NOW Field-Tested . . . Field-Proven . . . FIELD-ACCEPTED

Just a year ago exacting field tests began on a new line of Camco equipment embodying a radically different approach to the accomplishment of a familiar purpose. Today it can be stated that the new concept more than lived up to expectations and proved that

Selective setting of subsurface locks and tools is far simpler, more positive

with CAMCO

MAGNASET



MAGNASET Nipple magnetic codings are governed by the spacing between magnet rings. This can easily be reset in the field.

Wide industry acceptance and demand have followed the field proving of Camco's MAGNASET, the advanced *electronic* method of setting subsurface locks and production tools in landing nipples in a tubing string.

Used on conventional steel wire line, MAGNASET equipment operates by the automatic electronic release of self-contained energy. This method has several inherent advantages over mechanical means of setting locks and tools.

SELECTIVE SETTING of your production tool where you want it is certain with MAGNASET, regardless of sequence or position of nipple in the string. The magnetically coded MAGNASET Selector Tool is actuated only by electronic "recognition" of a correspondingly coded, pre-selected MAGNASET Nipple.

POSITIVE LOCKING is effected by the firing of the Selector Tool cartridge. The MAGNASET Lock dogs set securely without jarring.

AUTOMATIC OPERATION of the Selector Tool when it reaches the pre-selected Nipple eliminates need for operator skill, makes MAGNASET virtually foolproof even in heavy mud or crooked holes.

NO COATING DAMAGE — MAGNASET tools require no contact with the tubing bore to set, have no locating projections to scrape plastic coatings.

UNEQUALLED VERSATILITY — Up to six differently-coded MAGNASET Nipples can be used in the tubing string, and magnetic coding of any Nipple can easily be changed in the field. One basic lock operates in all Nipples. MAGNASET Side Port equipment and a complete line of Camco production tools are available.

Your CAMCO representative will gladly tell you more about field-proven, field-accepted MAGNASET, soon to be available in all areas. Ask him, or write for a complete brochure.

CAMCO

"PRODUCING PETROLEUM PROGRESS"

CAMCO, INCORPORATED *Box 14484, Houston 21, Texas*

Subsidiary Plants: CAMCO, LIMITED, Belfast, U.K. - CAMCO DE MEXICO, S.A., Mexico, D.F.

New Visco Well-Treating Formula Penetrates, Loosens, Disperses Deposits in Tanks, Lines, Tubing

Lowered pumping pressure, Tripled production, Dispersed solid paraffin... Among Spectacular Performance Results with Visco 1111

Visco 1111, on the job in oil and gas producing wells, water-injection wells and salt water disposal systems, has amazed even the most optimistic with its performance and economy. Here are a few examples of how it works to penetrate, loosen and disperse deposits of paraffinic-asphaltic compounds, carbonate scale, sodium salt deposits, iron compounds and other materials causing loss of production.

Cuts Pumping Pressure 175 psi

Injection pressure was 325 psi on a water injection well. Foreman believed pressure was due to a tight formation, but agreed to a test of Visco 1111. Pressure is down to 150 psi—and staying there, with one-gallon-per-day dosage of Visco 1111.

7-Well Cleanup Nets 60 bbl. Increase

Sticking pumps, caused by scale build-up, were causing frequent rod-pulling jobs on a 7-well East Texas lease. Visco 1111 cleaned up the pumps and tubing, upped production 60 bbl. per week. Company now using Visco 1111 on all their wells in East Texas.

Stopped Reperforating Need

On another East Texas lease, wells making high salt water with low-gravity oil tended to scale up and require periodic reperforation. Visco 1111 was given a trial on a well making only 3 bbl. oil and 20 bbl. water a day... quickly jumped daily production to 23 bbl. oil and 60 bbl. water. Cost: only $23.50 . . . as against $300 to reperforate.

Solid Foot of Paraffin Gone

A 500 bbl. tank contained 470 bbl. oil and a 12-inch paraffin bottom—so hard that an oil thief would not drop through. 5 gallons of Visco 1111 and 48 hours later the tank went on at 0.5% B.S. & W., *and no bottom at all.*

Easy to Use, Too!

Visco 1111 has excellent blending characteristics under a variety of field conditions, and does not gel when added to water. Your Visco Service Man will be glad to help you determine proper Visco 1111 dosages for best performance and economy on your leases. Ask him about this new well-treating product . . . or write us, today, for detailed product data.

VISCO PRODUCTS COMPANY
Incorporated
A Unit of Nalco Chemical Company
1020 Holcombe Boulevard **Houston 25, Texas**

Visco®
. . . Serving the Oil Industry through Practical Applied Science

Visco CHEMICALS
Visco SERVICES

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Another
of the invisible extras that
insure MORE ON-BOTTOM TIME
with LINK-BELT FR®
roller chain

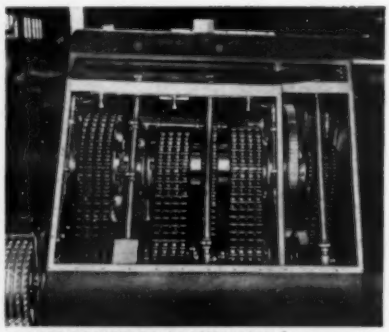
Optical comparator inspection guarantees

precision of every part

Precision is *rigidly practiced* in every step of Link-Belt's roller chain production. The optical comparator is an example of the specialized equipment used to assure precise manufacturing control of chain parts and tools. It is capable of magnification up to 100 times.

Continuous inspection is just one of the *invisible extras* that insure more on-bottom time with Link-Belt roller chain. Others include precise heat-treat control, prestressing, shot-peening, Fatigue Resistant FR* processing of sidebars.

U. S. Patent No. 2,517,497



GARDNER-DENVER DRAWWORKS incorporates Link-Belt FR roller chain.

Features like these are the reasons why users agree Link-Belt roller chain has greater capacity to withstand the smashing impacts and tortuous stresses met in day-to-day drilling.

For engineering assistance in applying FR roller chain, write Link-Belt Company, Indianapolis 6, Indiana. Ask any leading supply store for our Catalog 2980 containing full information on roller chain and other oil field equipment.

15,582

LINK-BELT COMPANY: Indianapolis 6, Houston 1, Dallas 26, Odessa, Tex., New Orleans 16, Shreveport, La., Los Angeles 22, (Montebello), Scarboro (Toronto 13); Export Office, New York 7. Distributors in All Fields.

LINK-BELT

ROLLER CHAINS AND SPROCKETS

GOOD EQUIPMENT

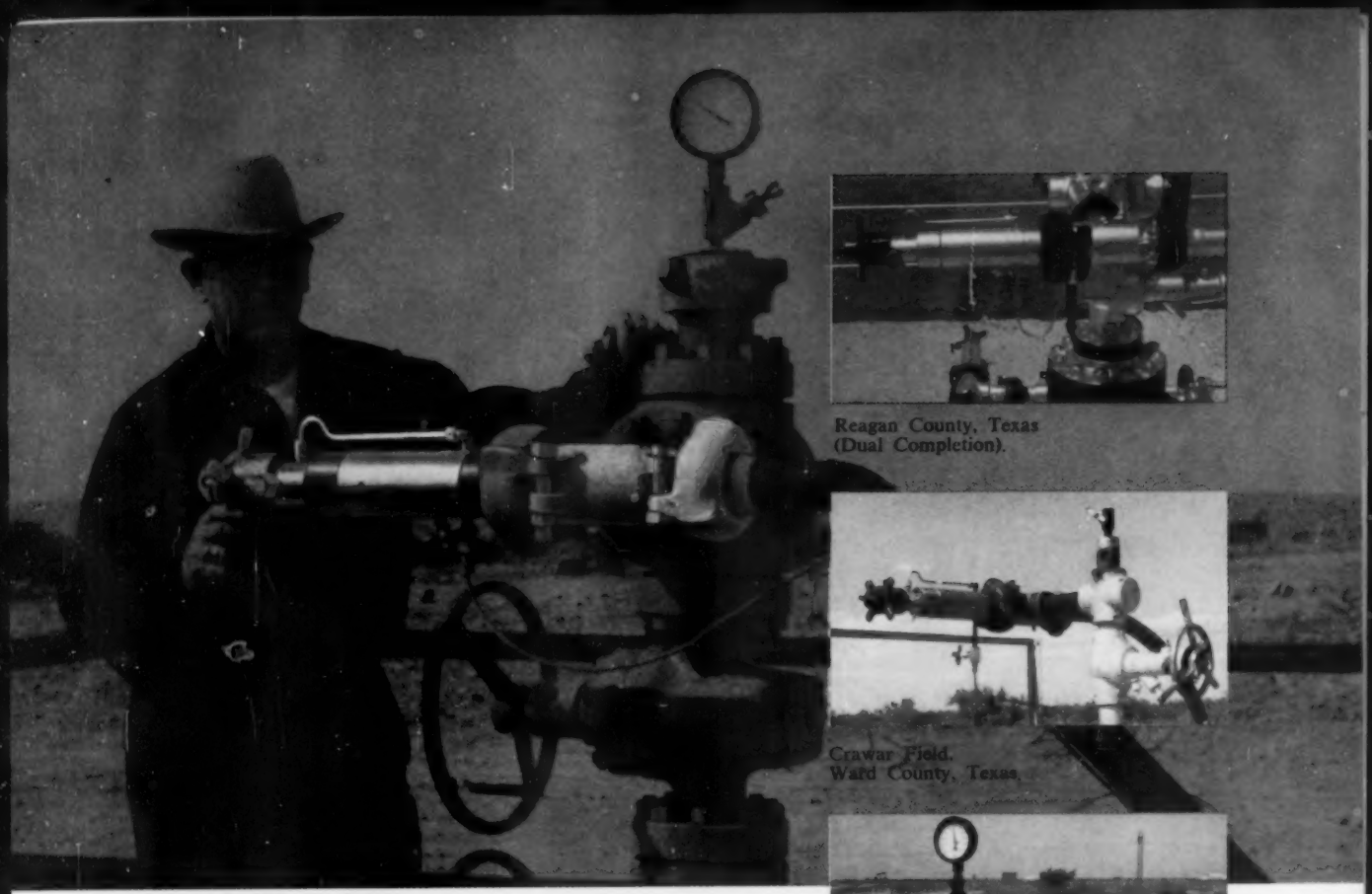
ASSURES MAXIMUM SAFETY TO CREW AND WELL

Good Equipment and safety to both crew and well go hand in hand. Franks Explorer provides fastest rig-up and operation with maximum safety. Speed is in the design, so there's no straining to do a fast job. Rig-up is faster with a telescoping derrick that moves strung-up, raises hydraulically, is simple to level. Automatic features eliminate many safety hazards. Air lift transfer provides speed in pulling, and stacking affords protection to rods and tubing. See a Franks representative or write for details on the various Explorer models.

WELL SERVICING AND DRILLING UNITS
FRANKS
PAMPA, TEXAS
CABOT

CABOT CORPORATION
MACHINERY DIVISION

Worth more when you BUY 'EM . . . Worth more when you TRADE 'EM



Reagan County, Texas
(Dual Completion).

Crawar Field,
Ward County, Texas.

Monument Field,
New Mexico.

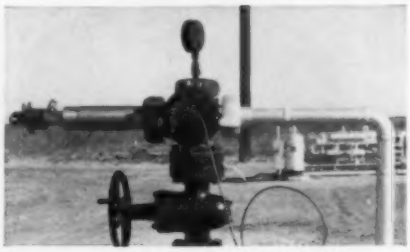
"PRESSUREMATIC"

it's both a wing valve and a high/low safety valve

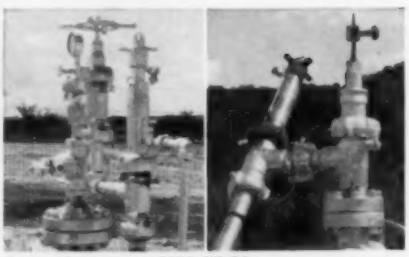
Here is a valve that does the work of two valves yet costs little, if any, more than a good high pressure valve alone. It operates manually for choke changing, or automatically as a high-low safety valve.

The **UNIBOLT PRESSUREMATIC VALVE** combines all of the time-tested and proven features of the Unibolt Adjustable Wing Valve with a novel automatic actuating accessory. The valve closes instantly when a pre-determined pressure balance across the seat is disturbed. The actuating mechanism consists of a small piston which is exposed to well pressure and a larger piston which is exposed to flowline pressure. A broken flowline or open valve, for example, in the production system, would lower the flowline pressure and thus instantly close the valve. Once closed, the valve may be easily opened and set manually for automatic operation. The downstream or low pressure line may be tapped at any remote point and thus embrace any desired portion of a gathering and treating system. Offshore and other remotely controlled wells could be shut in automatically in case of fire, ship collision, etc. The unique design lends itself to many such applications.

Send for literature or contact your nearest UNIBOLT sales representative.



Monument Field,
New Mexico.



Left—Lancaster Hill Field
(Ozona area, West Texas);

Right—Reeves County, Texas
(Dual Completion).

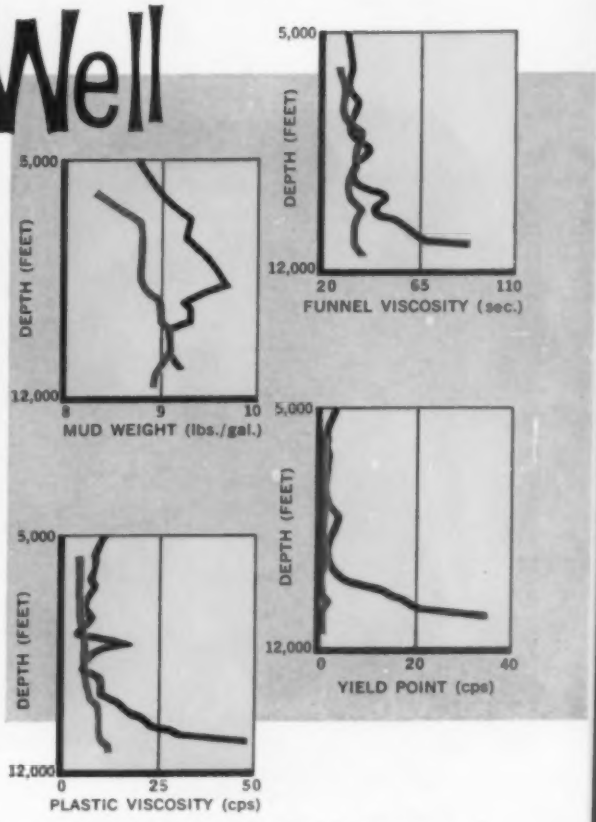
UNIBOLT

THORNHILL CRAVER CO.

P. O. Box 1184, Houston, Texas

ATLAS EMULSIFIER saves $13,710 on Wyoming Well

Better flow properties, lower solids, less oil used plus savings of $13,710 in bits and rig time! Such is the record established by Signal Drilling and Exploration Company on Government Ackridge No. 1 for operator Max Pray. Located in the Grizzly Buttes Field of Unita County, Wyoming, Government Ackridge No. 1 was compared with a nearby well in adjacent Sweetwater County. With rig size and other drilling factors being equal for the comparison interval of the two wells, the savings effected are directly attributable to the difference in mud programs. From the intermediate casing point both wells were drilled with an oil emulsion . . . Government Ackridge No. 1 used an Atlas Emulsifier. In this 6,000′ interval Government Ackridge No. 1 was drilled in 188 fewer hours using 10 fewer bits—a clear saving of $13,710 in addition to a substantially lower mud bill.



Atlas emulsifier is sold through distributors under these tradenames . . . each is the product of Aquaness Department, Atlas Powder Company:

TRIMULSO®

Distributed by Baroid Division, National Lead Company

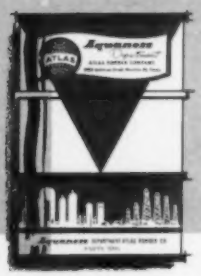
Registered trademark Baroid Division, National Lead Company

DRILLING MILK

Distributed by Magnet Cove Barium Corporation

Registered trademark Magnet Cove Barium Corporation

Drilling Milk
A SPECIAL EMULSIFIER FOR CLEAR WATER DRILLING AND LOW SOLIDS FLUIDS
MAGNET COVE BARIUM CORP.
HOUSTON, TEXAS



ATLOSOL

Distributed by Milwhite Mud Sales Company and other selected mud companies

Registered trademark Atlas Powder Company

ATLAS EMULSIFIERS IMPROVE A GOOD DRILLING FLUID
Because Atlas oil-in-water emulsion muds provide better oil action, they improve hole conditions, extend bit life, and increase penetration rates.

Better Hole Conditions. Atlas oil emulsion decreases torque as much as 50% . . . the hole is kept cleaner and pump pressures are correspondingly lower. There is less danger in lost-circulation and low-pressure zones.

Longer Bit Life. Atlas oil emulsion prevents balling, provides better cutter and bearing lubrication. Greatly extended bit life reduces bit costs, reduces rig hours lost to trip time.

Faster Drilling Rates. Atlas oil emulsion makes more feet of hole per hour. Oil lubrication combines with improved hole condition to increase drilling rates in competent and troublesome formations.

ATLAS Aquaness CHEMICALS ATLAS POWDER COMPANY

Aquaness Department, Atlas Powder Company

P. O. Box 21072 • Houston 26, Texas

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

THE *INSIDE STORY* OF GROVE *VALV-PAK*

Compact · Versatile

Trouble-Free

Grove Seal-"O"-Ring® Valv-Pak combines the compactness and light weight of an integral Christmas Tree valve assembly with the flexibility of a conventional wellhead manifold that permits any single component to be changed without replacing the complete unit.

CHECK THESE GROVE VALV-PAK FEATURES:

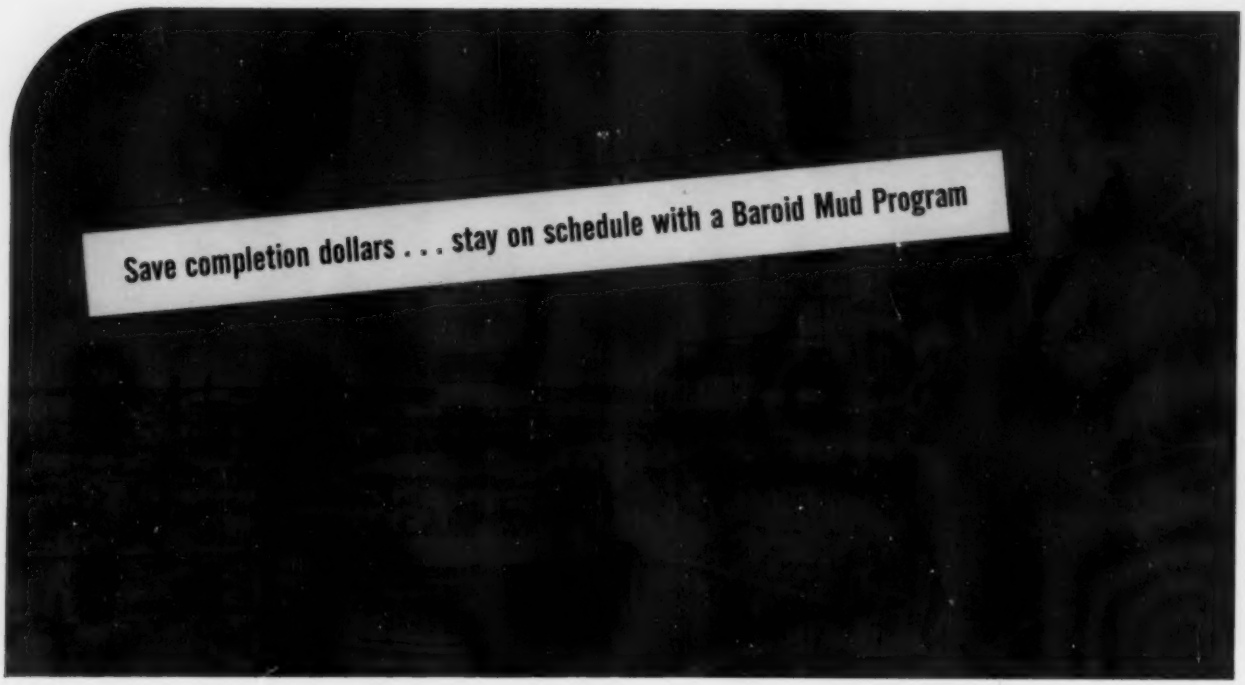
1. Patented Grove Seal-"O"-Ring design for double-action seal. Metal inner seat rings give primary metal-to-metal seal backed up by O-Rings.
2. Precision-finished stems with lifetime lubricated ball bearings.
3. No lubricants or sealing compounds needed. Squeegee action of O-Rings against gate assures a clean polished surface for bubble-tight metal-to-metal seal.
4. Adaptable to meet any need. Unique Grove Valv-Pak construction gives ultimate flexibility. Valv-Pak can be factory tailored to your precise needs. Parts damaged by erosion or corrosion may be replaced in the field faster and more economically than with conventional designs.
5. Wing valve cross can be furnished in full opening or reduced port design.
6. Swabbing valve (optional).
7. Through conduit, full opening design for ideal flow characteristics and for accommodating down-hole tools.
8. Top and bottom flanges may be supplied to accommodate any wellhead fabricator's specification.
9. Studs furnished for all flanged outlets.

GROVE PRODUCTION VALVES

GROVE VALVE AND REGULATOR COMPANY
A Subsidiary of Walworth

6529 HOLLIS STREET • OAKLAND 8, CALIFORNIA
Offices throughout the United States and in Western Canada

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



BAROID ENGINEERING SOL

Baroid Field Report: Jim Hogg County, Texas

MUD PROBLEM:
Reduce the filtrate loss of an oil that is used as drilling fluid to drill and complete in water-sensitive sands.

WELL DATA

LOCATION: Jim Hogg County, Texas
Total Depth: 2,938'

MUD ADDITIVE PROGRAM

0' to 2918'	Drilled with AQUAGEL* and water. At 2918' set and cemented casing. Cement was drilled from casing, and fluid in hole was displaced with diesel fuel. As diesel fuel was circulated, 5 lb/bbl DURATONE** was added through mud-mixing hopper, followed by addition of about 10% by volume water.
2918' to 2938'	Drilled in open hole using DURATONE, oil and water mixed as above. Well completed and put on pump-production without difficulty.

TYPICAL MUD PROPERTIES

Filtration, API, of this DURATONE-oil-water fluid was 10.1 cc, all oil.

CASING PROGRAM

5½" casing set and cemented at 2918'. Open-hole completion to 2938'.

PROBLEM: To achieve an economical oil-mud with a low filtrate loss that gives maximum protection while drilling in a water-sensitive pay zone.

DISCUSSION: Several wells have been drilled and completed in shallow, water-sensitive Colorado sands in Jim Hogg County, Texas. Open-hole completions were made, and it was thought that considerable formation damage had resulted from water-filtrate invasion. Serious consideration was given to using cable tools for drilling-in, as a means of overcoming this problem.

SOLUTION: DURATONE solved the problem by controlling the filtration of the oil, thus providing an economical oil-base completion fluid that protected the water-sensitive producing sands. Diesel oil, 5 lb/bbl DURATONE, and 10% by volume water were the only materials used. The cost of the DURATONE was $1.80/bbl of finished fluid. Mixing the DURATONE through the hopper while circulating resulted in tight emulsification of the water and a low API all-oil filtrate. Completion was successful, economical, and pump-production was achieved without difficulty.

*REGISTERED TRADEMARK, BAROID DIVISION NATIONAL LEAD COMPANY
**TRADEMARK, BAROID DIVISION NATIONAL LEAD COMPANY

BAROID — *Still Pioneering Drilling Mud Research • Engineering • Marketing*

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

VES COMPLETION PROBLEM

Economical and successful open-hole completions in water-sensitive sands by use of Baroid's new DURATONE is making this unique product popular in many fields.

In this case history in Jim Hogg County, Texas, completion difficulties and poor production were previously blamed on formation damage by filtrate from conventional water-base muds. A change to cable tool methods for completion was being considered until Baroid's new DURATONE was proposed as a low-cost solution. This drilling-in and completion fluid was made up with diesel oil, 5 lb/bbl DURATONE and 10% by volume water. Drilling was trouble-free and completion was successful.

DURATONE is a dry powdered organophilic colloid that controls filtration of all oil-base mud systems. DURATONE is compatible with crude oil, diesel oil, oil-base emulsions and oil-base muds. DURATONE has been successfully used on drilling, coring, completion and work-over operations. DURATONE improves flow properties, in addition to controlling filtration of oil-base systems at temperatures up to 400 F.

DURATONE oil-fluid additive was developed by Baroid research and engineering to perfect the properties of Baroid's DRILOIL* oil-base mud and INVERMUL* oil-base emulsion mud. Baroid's customer oriented products and services save you drilling and completion dollars and keep these operations on schedule.

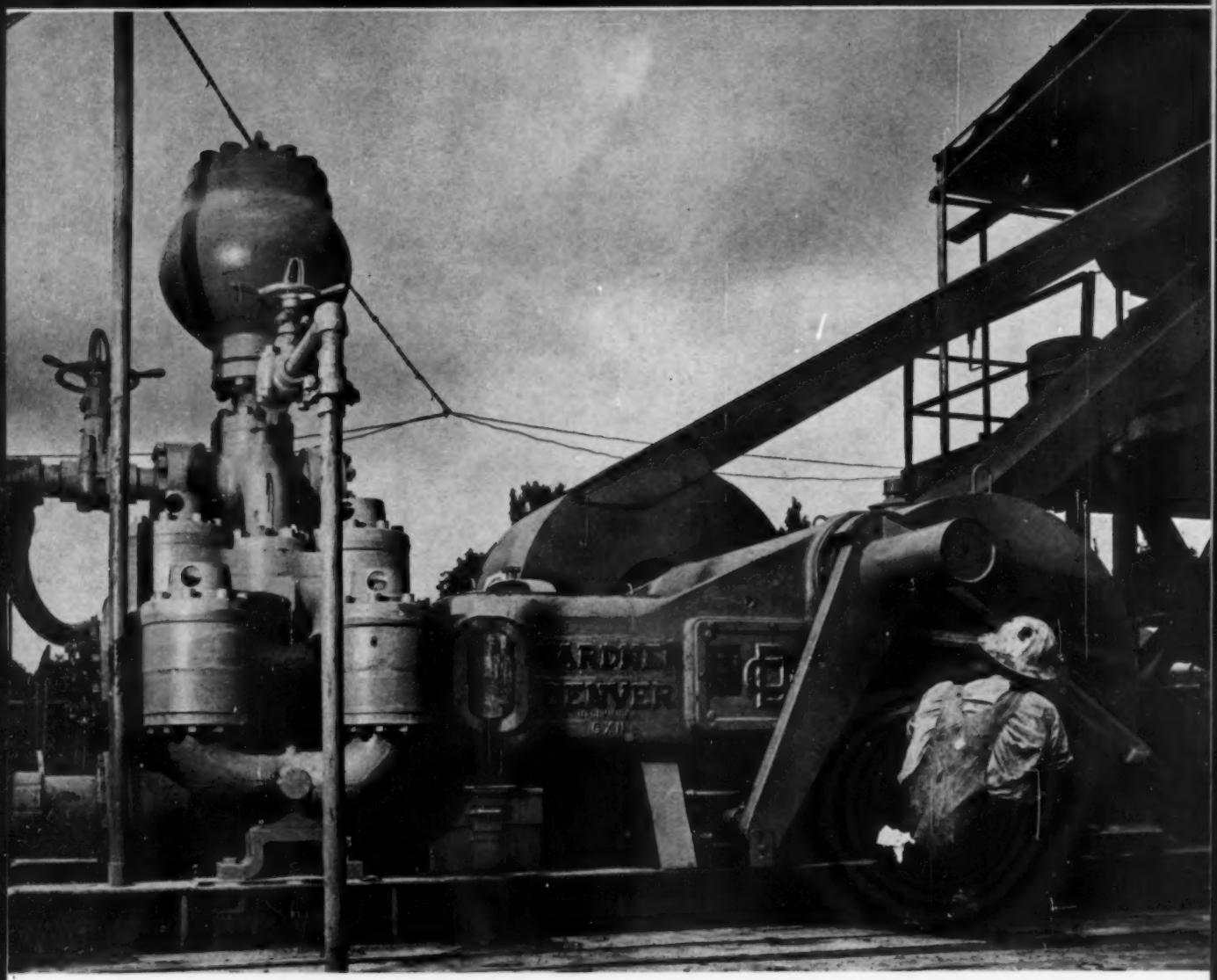
BAROID

BAROID DIVISION NATIONAL LEAD COMPANY
MAIN OFFICE: P. O. BOX 1675, HOUSTON 1, TEXAS

6121

Gardner-Denver Mud Pump parts are easily replaced at the rig site. J&L Supply stores in the United States and Canada stock the parts. This is how to.....

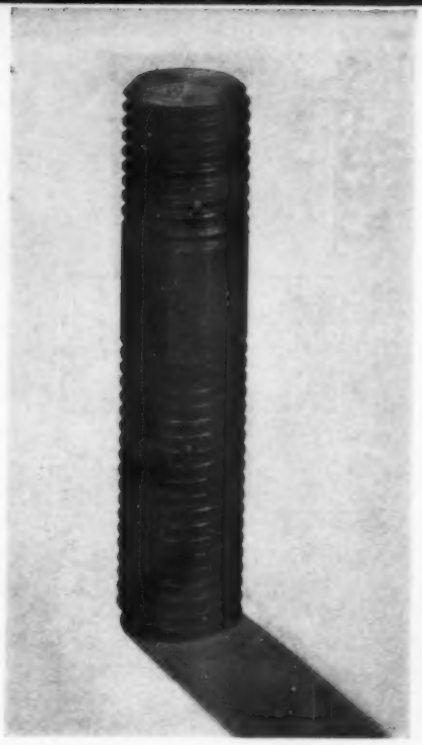
Simplify



This GXN is one of two Gardner-Denver mud pumps in tandem arrangement on a wildcat in Louisiana. Gardner-Denver engineers designed these pumps for complete service in the field. And Gardner-Denver mud pump parts are as near as your J&L Supply store. Unitized, trailer-mounted, offshore—any rig with Gardner-Denver mud pumps is never handicapped for lack of experienced Gardner-Denver service or genuine Gardner-Denver parts.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Mud Pump Maintenance



SAFEGUARD AGAINST RIG BREAKDOWN.

There is a difference in valve cap studs. Gardner-Denver studs are machined from alloy steel and heat treated.

To avoid costly failures, damaged equipment, insist on genuine Gardner-Denver parts. Protect your investment in quality.

Ask your J&L Supply man for literature on Gardner-Denver mud pumps in sizes to 1250 h.p. for drilling to any depths.

Jones & Laughlin

SUPPLY DIVISION – Tulsa

If it's sold by J&L....it's the best available

113

another
TRETOLITE SERVICE
report

FLUDEX*

Water Flood Additive stops filter channeling

BACKWASH ALSO ELIMINATES IRON SULFIDE, OIL DEPOSITS

Inspection of the filtering elements in a mid-continent water-flood operation revealed that these elements were rapidly losing their efficiency due to oil clogging, iron sulfide deposits, and channeling in the graded anthracite media.

Filters backwashed with **FLUDEX** *Additive*

To correct these difficulties, the filters were backwashed, using FLUDEX Water Flood Additive in the following procedure:

Allowing water to stand on media to depth of 6-8 inches, 10 gallons of FLUDEX Water Flood Additive were introduced into filter. This was allowed to soak for about 20 hours. When the normal backwashing operation was begun, the effluent showed substantial quantities of oily material and iron sulfide. Backwashing was continued until effluent ran clear.

FLUDEX *now regular part of maintenance program.*

The inspection plate was then removed and visual inspection made. There were no holes or channels in filter media; it was also free of oil and iron sulfide. Results were so satisfactory that all filters in this water flood operation now undergo regular FLUDEX treatment as a routine maintenance measure.

Find out how FLUDEX can fit into *your* operation. Ask the Man in the Red Car. Or write to . . .

*FLUDEX *is a registered trade-mark of Petrolite Corporation.*

TWF-60-4R

PETROLITE CORPORATION

SUBSIDIARY AND AFFILIATED COMPANIES
CANADA, Edmonton, Alberta • ENGLAND, London
GERMANY, Frankfurt, a. M. • VENEZUELA, Caracas

TRETOLITE COMPANY
DIVISIONS
369 Marshall Avenue, Saint Louis 19, Missouri
200 South Puente Street, Brea, California

REPRESENTATIVES
ARGENTINA, Buenos Aires • BRAZIL, Rio de Janeiro • COLOMBIA, Bogota
ITALY, Rome • JAPAN, Tokyo • KUWAIT, Kuwait • MEXICO, Mexico, D. F.
NETHERLANDS, The Hague • PERU, Talara • TRINIDAD, Port of Spain

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Trinity **Lite-Wate** Cement

has done what the operator set out to do in over 1500 wells in the past year.

HERE ARE THREE:

1

ECTOR COUNTY, TEXAS

Cemented 3,383 feet, 4½-inch casing. Slurry weight 12.5 to 12.7 pounds. Tailed in with 13-pound slurry. TRINITY LITE-WATE all the way. Job successful.

2

ST. CHARLES PARISH, LOUISIANA

Cemented 9⅝-inch surface casing in 15-inch hole, badly washed out. 12.5-pound slurry returned to 25 feet from surface, using 13.5-pound slurry for tail in. Nippled up after 12 hours... drilled out of 9⅝" in 26 hours... tested with 3500 lbs. per square inch. TRINITY LITE-WATE all the way. Job successful.

3

TERRELL COUNTY, TEXAS

Cemented 13,752 feet of 7-inch casing. Used TRINITY LITE-WATE cement 12.7-pound slurry with .8% LWL 20% Silica Flour. Brought cement back to 5,484 feet in one stage for fill up of 8,268 feet. Tailed in with INFERNO and 4% Gel. Job successful.

In the range of lightweight cement slurries, TRINITY LITE-WATE produces a slurry which is:

1. Sulfate resistant for lasting casing protection.
2. Remains impervious to migrating fluids.
3. Light enough to circulate.
4. Strong enough for any casing seat.
5. Strong enough to permit hydraulic fracturing.
6. Easy to mix, easy to pump.

TRINITY LITE-WATE can be used in most wells by just adding water. For special conditions it is compatible with accelerators, retarders, LWL agents and some other additives. For complete laboratory data call your local Trinity Representative or write Dallas Office, P. O. Box 2698 or phone RIverside 2-8111.

75 lb. Dry Volume per cubic foot

TRINITY

PORTLAND CEMENT DIVISION

GENERAL PORTLAND CEMENT COMPANY

GP CC

DALLAS·FT.WORTH·HOUSTON

An advanced new packer for production and well-stimulation

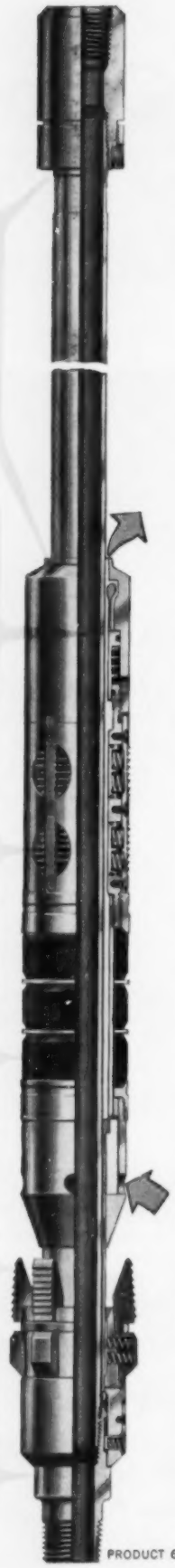
THE *BAKER* MODEL "R" DOUBLE-GRIP RETRIEVABLE CASING PACKER

A long-stroke (30″) packer with simple one-turn right control-pin setting, automatic bottom and hold-down... for combination acidizing, fracturing and production operations.

Now Baker brings new convenience, new reliability, to the familiar long-stroke production packer with hold-down.

This results from a new design concept that moves the hold-down from the tubing to the packer, placing it below the bypass valve. This restores surface control of the bypass valve for pressure equalization, eliminates button dulling, and provides dependable release of the hold-down.

And, back of the Model "R" is the Baker service organization. Domestically, 62 Baker field-service warehouses stand ready to supply packers, parts and repair service. Ask one of the 400 Baker servicemen to give you the complete story on both the Double-Grip and Single-Grip (no hold-down) versions of the Model "R" Packer.



HERE'S HOW THE NEW DESIGN CONCEPT WORKS...

(1) Note that the *Bypass Area* through the packer is completely isolated from the packer mandrel and tubing. Pressure surges in the tubing cannot dull buttons while running in or retrieving. Solids in tubing fluid cannot compact behind buttons and prevent retraction.

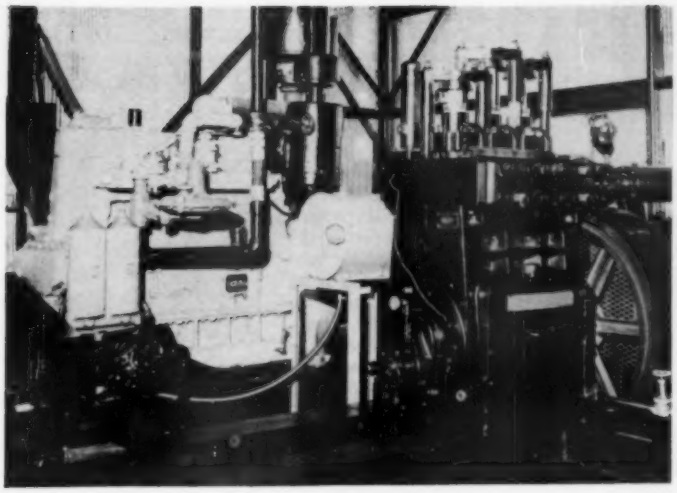
(2) Note that the *Hold-Down* is a part of the packer, not attached to the mandrel... leaving the bypass valve free for instant pressure equalization.

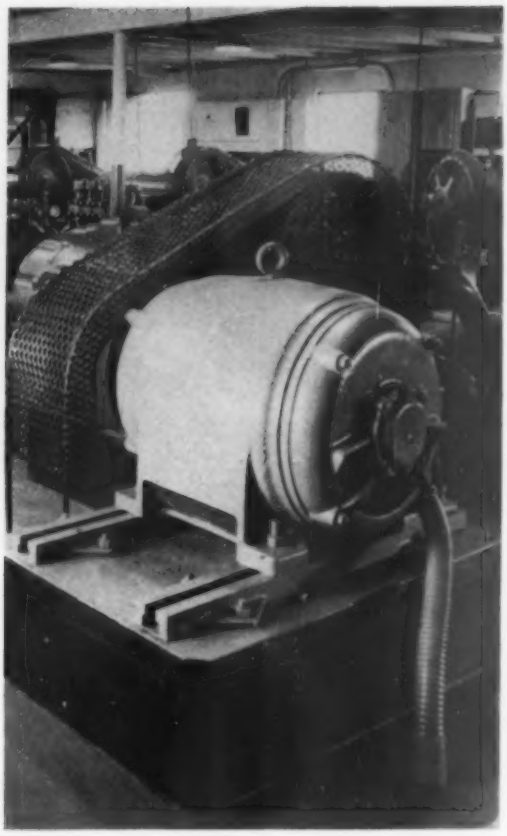
(3) Note that a *Differential Lock* holds the bypass valve closed without requiring high set-down weights... yet can be instantly released by picking up on the tubing.

The new concept in long-stroke packers is fully explained in Bulletin 385. Write: Baker Oil Tools, Inc., P. O. Box 2274 Terminal Annex, Los Angeles 54, California

BAKER
BAKER OIL TOOLS, INC.
HOUSTON / LOS ANGELES / NEW YORK

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD





JOHN M. STEVENSON
Engineering Consultant
Dallas, Texas

GAS ENGINES OR ELECTRIC MOTORS

THE DISCOUNTED CASH FLOW METHOD is applied to a gas engine versus purchased electric power installation cost analysis in much the same way it is used in oil property evaluations. The initial installation cost is used at its actual value and the net operating costs over the life of the project are discounted at appropriate discount factors for the years incurred.

PRELIMINARY ANALYSIS

In some areas and types of installations, a preliminary analysis will show a clear cut economic advantage of one power source over the other. However, there are other cases where a preliminary analysis shows no particular economic advantage of gas or purchased electric power. In such instances, the more detailed cash discount flow cost analysis must be made over the expected life of the project to provide engineering management an accurate basis upon which to make a decision.

Short-Cut Analysis

In order to save time in the preliminary planning stages, a shortcut method of evaluation was devised. The curves in Fig. 1 simplify and expedite a reasonably accurate comparison of costs. Based on an abbreviated discount cash flow analysis shown on Table 1, these curves give the total overall cost for various natural gas and electric power rates for installations of 5, 10 and 15-year life. These cost data are quite accurate for 60 to 300-hp installations.

Basis of Analysis. Initial installation costs have been used at full value and operating costs discounted at 6%. These costs have not been projected and discounted for each year as required by a more detailed analysis. Rather, these costs have been totalled for the 5, 10 and 15-year installation life, and then discounted by the appropriate 6% discount factor.

This abbreviated method is accurate if the total operating costs, depreciation and taxes are the same for each year throughout the project's life. This is seldom the case, and a detailed discounted cash flow analysis as shown in Table 3 must be made using actual projected costs for each year and applying appropriate discount factors.

In preparing Table 1, electric energy costs ranging from 0.75¢ per kwh to 1.5¢ per kwh and gas costs ranging

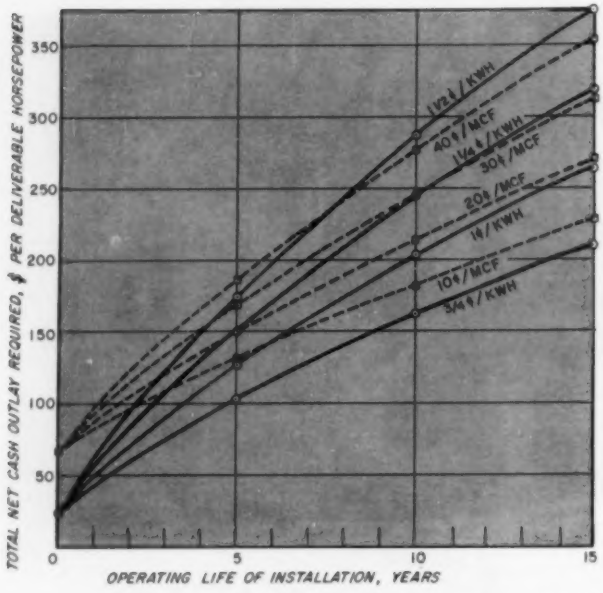
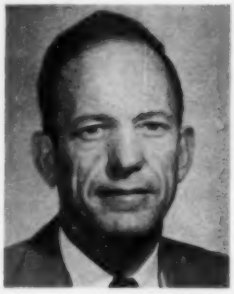


FIG. 1. **Total net cash outlay required** in dollars per deliverable horsepower for gas engine and electric motor installations from 60 to 300-horsepower and for operating life of 5, 10 and 15 years at various natural gas and electric energy costs. (Data from Table 1.)

ABOUT THE AUTHOR



John M. Stevenson was graduated from the A&M College of Texas in 1937 with a bachelor of science degree in mechanical engineering. His experience in the petroleum engineering industry includes four years with Phillips Petroleum Company in Bartlesville, Oklahoma, and five years with The Youngstown Sheet and Tube Company in Dallas, Texas, as a development engineer. More recently, he served as a senior mechanical engineer with Delhi-Taylor Oil Corporation in Dallas, where he directed the mechanical engineering and corrosion control section of the Production Division.

Since July 1958, he has served as a consulting engineer in Dallas, specializing in problems of petroleum production, pipelines, and corrosion, as well as new product development, welding, materials, inspection, and patent development.

from 10¢ per Mcf to 40¢ per Mcf have been used. From the curves in Fig. 1, with the fuel costs, energy cost and life of the installation known, the overall cost of the installation can readily be determined. For example: consider an installation requiring 100 delivered horsepower with an expected life of ten years, at a gas cost of 20¢ per Mcf, and electric energy cost of 1.0¢ per kwh. If gas engines were installed, unit cost would be $215.00/hp; the total cost, $21,500. If electric motors were installed, the unit cost would be $208.00/hp, and the total cost $20,800. During the life of this installation $700.00 would be saved by using purchased electric power.

The analyses in Table 1 and curves of Fig. 1 are based on average values and are intended for use only in preliminary planning. Unless the differences in cost shown in the curves indicate a wide variation in overall plant costs, a detailed analysis must be made. In a location where natural gas cost 30¢ per Mcf, and purchased electric power cost 1.00¢ per kwh for a ten year installation life, an unusual situation must exist before the overall cost of a gas engine installation would be less than one using purchased electric power. On the other hand, if the gas cost were reduced to 20¢ per Mcf, the overall costs of gas engines and purchased electric power are close enough to make a detailed study mandatory if the lowest overall cost for the life of the installation is to be achieved.

Engine and motor costs. The engine and electric motor costs are based on average published net prices plus installation costs in $/deliverable shaft horsepower. The average prices of engines and motors in the 60 to 300-hp range was fairly constant at an installed cost of $66 for engines and $24 for motors, both operating at reasonable speeds. This price includes only the normal minimum safety controls on the engine, and the starting equipment for the motors. It does not include fuel lines, cooling water supply, or special equipment for the engine, or electric lines, transformer banks or special equipment for the motors.

In neither case has any operating cost been charged for electrical auxiliaries such as lights, small pumps, etc. that are usually found at installations in this size range. In the case of the engine driven installation, the operating cost of such auxilliaries would be two to three times greater than those in the electrically-powered plant.

No salvage value has been allowed for either electrical or gas engine equipment when the installation is abandoned. The salvage value varies widely with location, local conditions, demand, and other factors, and such estimates are of questionable value. However, in cases where the salvage value can be reasonably estimated (as the example in Table 3), it should be considered.

Fuel consumption rates. In determining the engine fuel consumption, a brake thermal efficiency of 18% has been used for a fuel consumption of 14 cu ft per bhp hour when using 1000 Btu natural gas. This efficiency is somewhat below that shown on the test curves of naturally aspirated engines operated under laboratory test conditions. Perfect ignition and combustion resulting in maximum power at minimum fuel consumption are seldom achieved in gas engines operating under field conditions.

Most specific fuel consumption ratings are based on maximum delivered horsepower at a specified speed. In an average installation, a gas engine will not be required to operate constantly at full load. Engines operating at partial loads have a higher specific fuel consumption and lower thermal efficiency than at full load. Considering day in and day out operation for the life of an installation, this efficiency figure actually may be somewhat high. No derating factor has been applied to the engine for altitude or temperature and it has been assumed that the natural gas fuel will have a heat content of 1000 Btu.

Electrical energy consumption. In calculating electric energy consumption, an overall mechanical-electrical efficiency of 90% has been used for electric motors. This figure is somewhat below the 92-93% efficiency for the larger motors in the 60 to 300-hp range at full load, and slightly above

TABLE 1. Abbreviated Discounted Cash Flow Analysis for One (1) Installed Horsepower at Various Natural Gas and Electric Energy Costs for Installation Lives of 5, 10, and 15 Years for Installations Ranging From 60 to 300 Hp.

Gas Engine Installation

Cost of Natural Gas	10¢/Mcf			20¢/Mcf			30¢/Mcf			40¢/Mcf		
Project Life—Years	5	10	15	5	10	15	5	10	15	5	10	15
1. Equipment Cost ($66.00)	—	—	—	—	—	—	—	—	—	—	—	—
2. Fuel Cost	43.35	86.70	130.05	86.50	173.00	259.50	130.00	260.00	390.00	173.40	346.80	520.20
3. Maintenance Cost	40.00	80.00	120.00	40.00	80.00	120.00	40.00	80.00	120.00	40.00	80.00	120.00
4. Operating Labor Charges	100.00	200.00	300.00	100.00	200.00	300.00	100.00	200.00	300.00	100.00	200.00	300.00
5. Taxes and Insurance (2%)	6.10	12.20	18.30	6.10	12.20	18.30	6.10	12.20	18.30	6.10	12.20	18.30
6. SUB TOTAL	189.45	378.90	568.35	232.60	465.20	697.80	276.10	552.20	828.30	319.50	639.00	958.50
7. Depreciation (for 10-year life)	27.45	54.90	54.90	27.45	54.90	54.90	27.45	54.90	54.90	27.45	34.90	54.90
8. Total Expenses for Tax Credit (6+7)	216.90	433.80	628.25	260.05	520.10	752.70	303.55	607.10	883.20	346.95	693.90	1013.40
9. Credit for 52% Income Tax (52% of 8)	112.79	225.58	324.09	135.23	270.45	391.40	157.85	315.69	459.26	180.41	360.83	526.97
10. Net Total Operating Expenses (6 — 9)	77.00	153.00	244.00	97.00	195.00	306.00	118.00	237.00	369.00	139.00	278.00	432.00
11. Discounted Net Total Operating Expenses (6%	67.00	116.00	163.00	84.00	148.00	204.00	102.00	180.00	246.00	121.00	211.00	288.00
12. Initial Investment	66.00	66.00	66.00	66.00	66.00	66.00	66.00	66.00	66.00	66.00	66.00	66.00
13. Net Total Discounted Cash Expenses (11+12)	133.00	182.00	229.00	150.00	214.00	270.00	168.00	246.00	312.00	187.00	277.00	354.00

Electric Motor Installation

Cost of Electric Power	0.75¢/Kwh			1.00¢/Kwh			1.25¢/Kwh			1.5¢/Kwh		
Project Life—Years	5	10	15	5	10	15	5	10	15	5	10	15
1. Equipment Cost ($24.00)	—	—	—	—	—	—	—	—	—	—	—	—
2. Electric Power Cost	171.40	342.80	514.20	228.50	457.00	685.50	285.60	571.20	856.80	342.75	685.50	1028.25
3. Maintenance Cost	2.50	5.00	7.50	2.50	5.00	7.50	2.50	5.00	7.50	2.50	5.00	7.50
4. Operating Labor Charges	25.00	50.00	75.00	25.00	50.00	75.00	25.00	50.00	75.00	25.00	50.00	75.00
5. Taxes & Insurance (2%)	2.40	4.80	7.20	2.40	4.80	7.20	2.40	4.80	7.20	2.40	4.80	7.20
6. SUB TOTAL	201.30	402.60	603.90	258.40	516.80	775.20	315.50	631.00	946.50	372.65	745.30	1117.95
7. Depreciation (for 10-year life)	10.80	21.60	21.60	10.80	21.60	21.60	10.80	21.60	21.60	10.80	21.60	21.60
8. Total Expenses for Tax Credit (6+7)	212.10	424.20	625.50	269.20	538.40	796.80	326.30	652.60	968.10	383.45	766.90	1139.55
9. Credit for 52% Income Tax (52% of 8)	110.29	220.58	325.26	139.98	279.98	414.34	169.68	339.35	503.41	199.39	398.79	592.57
10. Net Total Operating Expenses (6—9)	91.00	182.00	279.00	118.00	237.00	361.00	146.00	292.00	443.00	173.00	347.00	525.00
11. Discounted Net Total Operating Expenses (6%)	79.00	138.00	186.00	102.00	180.00	241.00	127.00	221.00	295.00	150.00	263.00	350.00
12. Initial Investment	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00
13. Net Total Discounted Cash Expenses (11+12)	103.00	162.00	210.00	126.00	204.00	265.00	151.00	245.00	319.00	174.00	287.00	374.00

the efficiency of the smaller motors at partial loads.

Load factors. In determining the fuel and energy consumption, a load factor of 70% has been used. Load factor is a measure of the utilization made of the maximum power requirements. It is the ratio of the average power required over a long period of time such as a month or a year to the maximum power required over a short period of time such as 15 minutes. Load factor may be based on an actual measured maximum power requirement or demand, or it may be based on an installed or deliverable power capacity.

Load factor is an important consideration too often neglected in determining overall fuel or electric energy consumption. By selecting a 100% load factor to arrive at fuel or energy requirements, the assumption is made that the installation will operate at 100% of full estimated horsepower capacity every minute during the entire year. This assumption presumes certain conditions that are impossible to achieve. This assumes, for example, that the estimate of loads and required horsepower are so accurate that there will be no change during a year's time, and it also assumes that there will not be one minute during the year when the installation will be shut down. In checking large numbers of oilfield installations, it was found that very few have load factors in excess of 70% on an annual basis. A typical example is that of an efficiently operated waterflood project with monthly load factors, based on metered demand, varying from 66 to 86%. The annual load factor was only 66% on metered demand. The load factor based on installed deliverable horsepower was considerably below this figure.

TABLE 2. Operating Data and Fuel and Energy Costs for a 200-Hp Installation.

1 Operating year	2 Hp requirements	3 Hp hr x 1000	4 Fuel Mcf/year	5 Fuel cost ¢/Mcf	6 Total fuel cost	7 Kw hr x 1000	8 Total cost of energy
1	200	1230	19,920	13	$2580	978	$10,470
2	160	981	13,720	13	1780	731	8,330
3	190	1170	16,380	15	2460	873	9,950
4	185	1130	15,820	15	2370	843	9,610
5	180	1100	15,400	15	2310	821	9,360
6	170	1040	14,560	16	2330	775	8,840
7	170	1040	14,560	16	2330	775	8,840
8	165	1010	14,140	16	2260	753	8,580
9	155	950	13,300	17	2260	709	8,080
10	145	890	12,460	17	2120	664	7,570

Prime mover maintenance. Engine maintenance has been based on a cost of $8 per deliverable shaft horsepower per year, and motor maintenance at $0.50 per deliverable horsepower per year. This figure is in line with published values. Maintenance includes all service and materials on an engine or motor and their accessories including lubrication. Accurate records kept by many companies show that the overall maintenance costs of gas engines are between $8 and $12 per deliverable horsepower per year and in some cases higher. Maintenance values based on the maximum installed horsepower can be lower than $8/hp-yr. since the installed horsepower rating is higher than the deliverable horsepower. This maintenance cost is applicable whether the maintenance is done by the operators own personnel or under a maintenance contract with an outside firm.

Gas engine operating costs. The cost of operating labor must be considered

in overall operating costs. A common practice is to charge such labor out as so many hours per day at the going field rate for labor. This is not a true picture of the cost of such labor. A more realistic approach shows that it costs $10,000 to $12,000 per year to keep a man capable of operating a plant on the payroll, and furnish him with tools, transportation, and other items needed. If he devotes full time to an installation, the full $10,000 must be charged to that plant. In arriving at a labor value for use in Table 1, it was assumed first, that a 500-hp plant would require the full time of one man costing $10,000. This need not be one individual, but may require the equivalent of one man's time divided between two or three men. This gives an average cost of $20 per hp-year for labor on a gas engine installation.

Electrical operating costs. With an electric plant, it was assumed that only ¼ as much time will be required, for a cost of $5 per hp-year. Even though one man may be assigned full time to a plant, less time will be required of him to oversee an electric plant.

Ad valorem taxes and insurance. The annual operating cost of ad valorem taxes and insurance have been set at 2% of the initial value of the installed equipment.

The discount factor used in this type of analysis should reflect the true value of deferred capital spending to the company concerned. It is not necessarily the rate at which the company may expect to borrow money, but rather the value to the company of postponing cash expenses. For most oil companies, the minimum discount rate used is 6%, the figure used in this paper. Discounted rates of 10% and even higher are used by many companies to evaluate postponed cash expenses.

Equipment depreciation. For the examples shown in Tables 1 and 3, straight line depreciations have been

TABLE 3. Discounted Cash Flow Analysis of a 200-Hp Installation Comparing Total Cash Expenditures Required for Gas Engines vs Electric Motors.

Year	Initial	1	2	3	4	5	6	7	8	9	10
Gas Engine Installation											
1. Equipment Cost	$16,270										
2. Fuel Cost		$ 2,580	$ 1,780	$ 2,460	$ 2,370	$ 2,310	$ 2,330	$ 2,330	$ 2,260	$ 2,260	$ 2,120
3. Maintenance Cost		1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600	1,600
4. Labor Cost		4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
5. Auxiliaries Operating Cost		820	820	820	820	820	820	820	820	820	820
6. Taxes and Insurance (2%)		330	330	330	330	330	330	330	330	330	330
7. SUB TOTAL	$16,270	9,330	8,530	9,210	9,120	9,060	9,080	9,080	9,010	9,010	8,870
8. Depreciation (for 10-year life)		1,460	1,460	1,460	1,460	1,460	1,460	1,460	1,460	1,460	1,460
9. Total Expenses for Tax Credit (7+8)		10,790	9,990	10,670	10,580	10,520	10,540	10,540	10,470	10,470	10,330
10. Credit for 52% Income Tax (52% of 9)		5,620	5,190	5,550	5,500	5,470	5,480	5,480	5,440	5,440	5,370
11. Net Total Cash Expenses (7—10)	$16,270	3,710	3,340	3,660	3,620	3,590	3,600	3,600	3,570	3,570	3,500
12. Net Discounted Cash Expense (6%)	$16,270	3,600	3,060	3,160	2,950	2,760	2,610	2,460	2,320	2,180	2,010
							TOTAL			$51,460	

Year	Initial	1	2	3	4	5	6	7	8	9	10
Electric Motor Installation											
1. Equipment Cost	$ 8,270										
2. Energy Cost		10,470	8,330	9,950	9,610	9,360	8,840	8,840	8,580	8,080	7,570
3. Maintenance Cost		100	100	100	100	100	100	100	100	100	100
4. Labor Cost		1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
5. Auxiliaries Operating Cost		270	270	270	270	270	270	270	270	270	270
6. Taxes & Insurance (2%)		160	160	160	160	160	160	160	160	160	160
7. SUB TOTAL	$ 8,270	12,000	9,860	11,480	11,140	10,890	10,370	10,370	10,110	9,610	9,100
8. Depreciation (for 10-year life)		740	740	740	740	740	740	740	740	740	740
9. Total Expenses for Tax Credit (7+8)		12,740	10,600	12,220	11,880	11,630	11,110	11,110	10,850	10,350	9,840
10. Credit for 52% Income Tax (52% of 9)		6,620	5,510	6,350	6,180	6,050	5,780	5,780	5,640	5,380	5,120
11. Net Total Cash Expense (7—10)	$ 8,270	5,380	4,350	5,130	4,960	4,840	4,590	4,590	4,470	4,230	3,980
12. Net Discounted Cash Expense (6%)	$ 8,270	5,230	3,990	4,430	4,040	3,720	33,30	3,140	2,900	2,580	2,290
							TOTAL			$48,540	

	Gas Engines	Electric Motors
Total Cash Expenditures With Income Tax Credit	$51,460	$48,540
Less Salvage After Taxes	— 930	— 1,830
Net Total Cash Expendatures	$50,530	$46,710

In This Case, Electric Motor Installation Is $3,820 Less

Net Total Discounted Cash Expense Without 52% Income Tax Credit

Year	Initial	1	2	3	4	5	6	7	8	9	10
Gas Engine Installation	$16,270	$ 9,060	$ 7,820	$ 7,960	$ 6,620	$ 6,970	$ 6,590	$ 6,220	$ 5,820	$ 5,490	$ 5,100
							Total			$83,920	
Electric Motor Installation	$ 8,270	$11,660	$ 9,040	$ 9,920	$ 9,090	$ 8,380	$ 7,530	$ 7,100	$ 6,530	$ 5,860	$ 5,230
							Total			$88,610	

	Gas Engines	Electric Motors
Total Cash Expenditures Without Income Tax Credit	$83,920	$88,610
Less Salvage Value After Taxes	— 930	— 1,830
	$82,990	$86,780

In This Case, Gas Engine Installation Is $3,790 Less

applied to 90% of initial equipment value. If other methods of depreciation and different residual values are used, they can readily be incorporated in the analysis framework.

The income tax credit on operating expenses is based on the normal corporate rate of 52%. For some operators, this tax rate may be higher than 52%, thereby giving an even greater credit against operating expenses. For those operators currently paying no income tax, two questions must be answered before determining whether or not to use this income tax credit against operating expenses: (1) Will there be any time during the life of the project when income tax will be paid? (2) Would there be taxable income from this property if the operating expenses were eliminated from the cost of doing business? If the answer is yes to either of these questions, the tax credit should be included in the cost evaluation.

EFFECT OF COST VARIATIONS

The ratio of initial installed costs of gas engines to electric motors ranges from 2:1 to 3:1, and the initial outlay of capital for engines is considerably greater than that for an electrical installation of comparable delivered horsepower. Where conservation of cash and deferment of expenditures is important, an electric motor installation has an advantage. This may be particularly important in installations where initial returns on the project are low, and gradually increase during the life of the project, such as in waterfloods or partially developed fields.

The initial investment ratio will likewise have considerable bearing on installations where loads decrease rapidly during the early life of the project. In such cases, the high initial investment in gas engines may more than offset higher operating costs of electric motors with a resulting lower overall cost of the project for electric motors. This assumes that due consideration is given to obtaining favorable electric service contracts[1] so that the project will not be burdened with high minimum electric billings during the latter stages when the energy requirements are low. In installations of this type, use of temporarily installed equipment sometimes can be used to advantage for high power requirements in early stages.

Installation life. Effect of the initial investment ratio on overall costs is influenced by the projected life of the installation. For relatively short lived plants, high initial costs of equipment increase the overall costs greatly, but for long lived plants, this effect is minimized. Where installation lives are indefinite, the best minimum and maximum lives should be selected and an analysis made for each. With such a study showing the relative costs of gas engines or purchased electric power for both the minimum and the maximum installation lives, management can better determine which installation will cost less.

Changes in fuel costs. In considering fuel costs, natural gas must be priced realistically for a fair appraisal. The days of free fuel where the costs of gas for engines could be neglected are gone in most areas. The cost of gas must be based on the price that such gas could be sold for if it were not used as engine fuel.

Possibility of the sale of existing casinghead or gas well gas should be carefully explored before setting the fuel cost of an installation. Likewise, the actual value of gas to a company should be carefully determined and values not based on averages or estimates. In a recent case evaluated by the author, it was originally estimated that the gas to be used for fuel was worth 11¢ per Mcf. A further check within the company showed that the gas was then worth 13¢ per Mcf and would escalate to 18¢ per Mcf during the life of the installation. The average value was slightly over 15¢ per Mcf. This raised the fuel cost of the gas engine installation by almost 40%.

In those areas where present casinghead gas has a market value of less than 10¢ per Mcf, it is seldom that purchased electric power is justified on cost alone. But a gas supply for the life of the project at the existing low rate must be assured.

BTU content of gas. In most cost analyses it is assumed that the natural gas used for fuel has a heat content of 1000 Btu per cu ft. In many localities, the heat content of gas varies considerably from this value. A variation of only 50 Btu per cu ft will increase or decrease the fuel cost by 5%. The fuel consumption should be corrected to account for variations from the commonly assumed 1000 Btu per cu ft.

Select best electric rate. The electric energy cost cannot be based on some average rate for the area, but must be based on values determined by an actual rate, and operating study for the particular installation. In most instances there are more than one electric energy rates that may be considered. It is to the advantage of the user to select the most favorable rate available.

Unit cost of electricity. In the case of gas used for most field installations, the cost of gas remains the same whether a small amount or a large amount of gas is used. This is not generally true of electric energy. The unit cost of electrical energy decreases as the consumption increases. This has an important bearing on the overall planning of an installation. This decrease in the unit cost of electrical energy as the consumption increases, dictates that as much of the load as possible at an installation be considered for electrification. If it proves economically feasible to use electric energy for part of an installation, it usually will prove even more fesible to make a complete electrical installation.

How Load Factors Work

The operating load factor will have an important bearing on the overall costs of an installation. Since fuel costs of gas engines are less than the energy costs of electric motors, variations in load factor will have less effect on the overall cost of gas engine installations than on electric motor installations. The cost of electric energy is a major operating cost component, and variations in load factor will control to a large extent the overall operating cost.

If the load factor selected for an analysis is above the actual operating load factor, the electric installation will show an unrealistically high operating cost. If the load factor is too low, the electric installation will show a low operating cost.

To arrive at true costs, the operator must determine the load factor with the greatest accuracy possible. This item is critical in the comparison of the two types of energy under consideration. If the load factor selected is too low, the gas engine installation is penalized, and if it is too high, electric power is penalized.

It would be an unusual installation where the annual load factor would exceed the 70% used for the analyses shown in Table 1 and plotted in Fig. 1.

Some idea in load factor estimating may help. A deep well turbine pump in a water supply well planned for around the clock operation would be expected to have a load factor close to 100%. In actual operation, the typical monthly load factor of such pumps is about 90%, and the annual load factor between 75% and 80%. This less than anticipated load factor likely results from uncontrollable variations in overall head and capacity requirements as well as down time and other unforseen changes in operation.

A major gas pipeline compressor station would be expected to have a higher monthly load factor than the average field installation. One such station operating during the month of February 1958, with nine engines each capable of delivering 1320 hp had an overall station load factor based on the deliverable horsepower of 61.3%. The maximum load factor for a single engine was 74.6%. Since February is normally a high load, constant rate

month for compressor stations, this monthly load factor based on deliverable horsepower, will be about the best that might be expected throughout the year. On an annual basis, even if operating conditions throughout the year were comparable to those of February, the annual load factor will be less than 61.3%.

SAMPLE OF A DETAIL ANALYSIS

If the short-cut (or general) comparison was made in the preliminary analysis and neither showed a distinct economic advantage, a more detailed study should be made. Table 3 shows a complete discounted cash flow analysis comparable to an installation recently evaluated where both the horsepower requirements and fuel costs varied during the life of the installation. A 6% discount factor and the same maintenance and labor costs shown in Table 1 were used for this analysis.

For this installation, the initial 200-hp requirement declined during the life of the installation to 145 hp. Fuel costs increased from 13¢ per Mcf to 17¢ per Mcf. The electric energy cost, labor, maintenance, and tax costs were unchanged during the life of this plant. Table 2 shows the fuel and energy requirements and costs used in the discounted cash flow analysis of Table 3.

This analysis of a fairly typical waterflood plant shows that the overall cost of gas engines would be $50,530 and for electric motors $46,710. The comparison shows it costs $3820 less to install and operate electric motors than gas engines. Since some operators feel they can neglect the 52% federal income tax in their evaluations, the supplementary analysis in Table 3 shows that the total operating cost with tax deductions eliminated for gas engines would be $82,990, and for electric motors would be $86,780. Under these conditions, the gas engines would cost $3790 less than the electric motors. If electric motors were installed in this plant, the non-tax-paying operator would pay $379 per year for the convenience of electricity.

Table 2 shows the final estimated requirements based on a 70% annual load factor. The fuel requirements are based on a brake thermal efficiency of 18% giving a specific fuel consumption of 14 cu ft per hp-hour, and the total fuel costs in Col.[6] are calculated from the actual value of the gas shown in Col.[5].

Electric energy consumption in Col.[7] has been computed from the annual horsepower requirements using a 90% motor efficiency.

Operating projections for this plant indicated that it would operate at a monthly load factor based on a metered demand of better than 80%. As previously pointed out, a monthly load factor higher than the annual load factor is normal. Applying this 80% monthly load factor to an existing electric rate in the plant area, gave a unit cost of 1.14¢ per kwh which was used in determining the total cost of electric energy shown in Col.[8].

It was planned to lay 3200 ft of 2-in. gas line if engines were to be used, and to install a 225-kva transformer bank if electric motors were to be used. In addition, electric auxilliaries such as lights and some small motors requiring an estimated 2000 kwh per month were to be installed.

The installed cost of the 200-hp gas engine was $13,710 plus $2560 for the 3200 ft of gas line for a total installed cost of $16,270. The installed cost of the 200-hp electric motor was $5390 plus $2800 for the 225-kva transformer bank for a total installed cost of $8270. Since other equipment costs were about

Cost Trends in Labor, Natural Gas

In making a detailed cost analysis of a given installation, it is essential, of course, that careful consideration be given to any known cost fluctuation affecting the overall costs during the project's expected operating life. While labor, field gas prices and electrical power rates vary with location and to some extent, size of the installation, it may be of considerable value to show some trends for those cost items that greatly affect the overall cost. These include labor, gas prices and electric power rates.

Labor Cost Trends

Fig. 2 based on data from the U. S. Bureau of Labor Statistics from 1950 to 1959 for petroleum and natural gas production workers shows a steady increase which has been projected to 1970. Wages have steadily increased, and with the present trend, projections of labor costs based on current wage rates will be less than the actual labor costs paid out during the life of an installation. This increase in wages affects not only the labor values used here, but also the maintenance cost, since labor is a big part of maintenance. At this writing, there is nothing to indicate that wages will decrease, and all indications are they will continue to in-

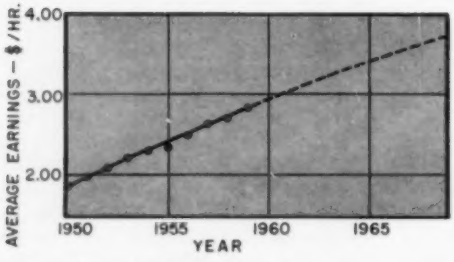


FIG. 2. **Average hourly earnings** of non-supervisory workers engaged in petroleum and natural gas production. Actual figures for 1950 through 1959 from U.S. Bureau of Labor Statistics and projected by the author to 1970.

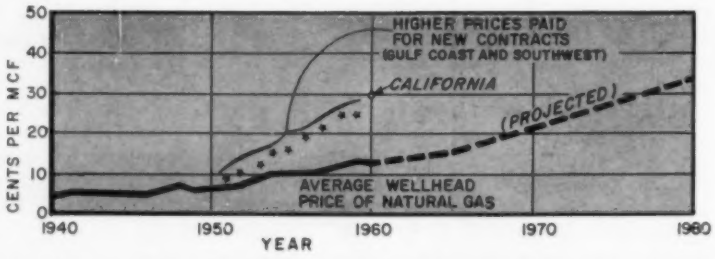


FIG. 3. **Natural gas cost trends** to 1980, from a paper by J. E. Kastrop, The Petroleum Engineer Publishing Company, presented before the Petroleum Electric Power Association, June 6, 1960.

the same for either the gas engines or the electric motors, there was no need to include these items in this analysis. In many installations, other equipment costs will not be the same for gas and electric installations. *These costs* must be included in the analysis.

Maintenance for the engine at $8 per delivered hp-year totaled $1600 per year, and for the electric motor at $0.50 per hp-year totaled $100 per year. The operating labor for the engine was $4000 per year and for the electric motor $1000/year. Forty percent of one man's time was assigned to operate this 200-hp engine plant. This amounted to 16 hours per week or slightly over 2 hours for each 24-hr day the engine is operated.

Labor cost for the electric motor amounted to 10% of one man's time or 4 hours per week or slightly over ½ hr per day. These operating costs were charged to the engine or motor only, and do not include necessary checks of other plant equipment. In the case of the engine, they would include such things as temperature checks, starting and stopping, checking oil, and water levels, engine speeds, throttle mixtures and the time to and from the plant to make such periodic checks.

The electrical auxiliaries for this plant would require an estimated 2000 kwh per month. With the gas engine, the cost of these auxiliaries at an existing electric rate for this type of service would be $63.37 per month for a total of $824 per year. With the electric motor installation, this auxiliary load would be billed on the same rate as the motor at $22.80 per month for a total of $274 per year.

The salvage value for the two plants shown in Table 3 was based on current values of used equipment in the plant area. To this figure, depreciation and capital gains tax were applied, and the resulting figure discounted at 6%. This gave a net discounted salvage value of $930 for the gas engine, and $1830 for the electric motor.

Other Variables to Consider

In this example, it was assumed that other items not discussed would remain the same with either prime mover. In some cases, this is an oversimplification. In a recent analysis, the overall cost of one particular project was controlled by the type of pumps selected. In this case, three types of pumps were considered: two were centrifugals; one was a piston pump. In the final analysis, an electrical installation with a piston pump was the least expensive. Although centrifugal pumps cost considerably less, their efficiency was lower, and the resulting higher operating costs more than offset the higher cost of the piston pump. This is not a unique or isolated case. In fact, most installations have variables involved other than the actual cost of gas engines or electric motors. All of these variables must be evaluated if the overall cost is to be realistic.

Bibliography

1. Stevenson, J. M., "Early Planning and Periodic Re-Evaluation Essential for Lowest Purchased Electric Power Cost," *The Petroleum Engineer*, Feb. 1960, pg. B-19.
2. Stevenson, J. M., "Equipment Management — Key to Economic Operations," *The Petroleum Engineer*, July 15, 1959, pg. B-19.
3. Allison, W. D., "Mechanical Reliability of Electric Motors in a Large Petroleum Refinery," 7th Annual Petroleum Industry Conference, American Institute of Electrical Engineers, Oklahoma City, Sept. 28, 1960.
4. Edmondson, P. B. and Evans, H., "Survey of Operating and Maintenance Expenses for Small Skid-Mounted Compressor Units," Petroleum Mechanical Engineering Conference of ASME, Denver, Colo., Sept. 21, 1958.
5. Manry, J. III, "Electronic Computer Provides a Daily Check on Compressor Engines," Petroleum Mechanical Engineering Conference, ASME, Denver, Sept. 21, 1958.
6. Smith, A. C., "Protective Maintenance — Maximum Profit with Minimum Investment," *Pipeline Engineer*, May 1960, pg. D-30. ★ ★

---

and Electricity

crease at some rate more or less comparable to past performance.

Wellhead Prices of Gas

Average U. S. wellhead gas prices from 1940 to 1959 from U. S. Bureau of Mines data are plotted on Fig. 3 and projected to 1980. This indicates a steady increase may be expected in the price of gas at the wellhead. As fuel prices increase, the cost of operating gas engines goes up as an increasing item of operating expenses. The average field price in 1960 was about 13.6 cents per Mcf.

Electric Power Rates

Fig. 4 depicts electrical energy rates for industrial and commercial users from 1950 to 1959 and projected to 1970. In both large and small commercial and industrial light and power users, the rates have declined slightly since 1950, and the projection shows no marked change. Both the large and small user can expect a slight rise by 1970.

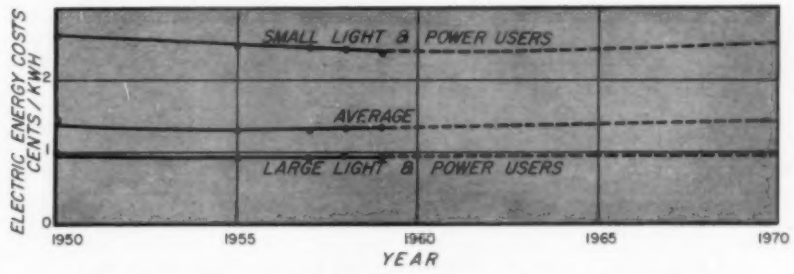


FIG. 4. **Electric energy costs** to commercial and industrial customers based on data obtained from the Federal Power Commission by Edison Electric Institute for years 1950 through 1959, and projected by the author to 1970.

What These Trends Mean

All three of these factors taken together indicate that those plants with minimum labor, maintenance and fuel costs today will maintain minimum overall costs for the life of the installation. Since plants using electric energy have lower labor and maintenance costs, and no fuel costs, an electrified installation with less overall cost today will show less overall cost for sometime to come. In plants using gas engines, the indications are that the overall costs can be expected to increase at a faster rate than those of plants using electric motors.

If further refinements are desired in making evaluations as shown in the example of Table 3, these cost trends may be incorporated in the appropriate cost items in determining the overall cost of a proposed installation. ★

242 DEEP WELLS ADDED IN 1960

ERNESTINE ADAMS

The 14th annual deep drilling survey showed that number of deep wells completed in 1960 was 242, a 6% increase over 1959 wells below 15,000 ft.

Table 7, a brief description of each well, is the second part of the report. The first part, published in March, lists new deep fields and discoveries made by record deep drilling. It also covers costs for overall average and by states of all deep wells drilled.

TABLE 7. DESCRIPTION OF WELLS IN THE UNITED STATES DRILLED 15,000 FT AND BELOW

1. TD, ft 2. Prod. depth(s)	Company well	Drilled by	1. Field or area 2. County/parish	1. Spudded 2. Completed	Mud program	Perfs. ft.	Initial prod/d, gravity, coke, tubing pressure.	Remarks
			CALIFORNIA					
15,044 4,280	Standard Calif. Peter Cook #11	R. B. Montgomery	Rio Vista Sacramento	10-17-59 3-24-60		4230-54 4265-80		FW. Eocene sd. 39' 164 days to drill
15,177 D&A	Shell Oil KCL 48-25	Co. Rig 7	Pleito Ranch Kern	1- -60 4- -60	Oil base mud			WC. Redrilled.
15,208 D&A	Shell Oil Pagenkopp #1	Co. Rig 13	Sespe Creek Ventura	5-21-60 9-13-60	Water base emul. mud			WC. 110 days to drill. Approx. 150 bits.
15,221 D&A	Texaco Shiells 202		Shiells Canyon	1960				WC.
15,344 15,343	Standard Calif. Burson #1	Kellogg Drlg. Co.	Fillmore area Ventura	8-22-60 10-25-60		15,213-343	300 b/d 30.4° 444 mcf $\frac{29}{64}$" CP 1000 TP 450	FWC. Spalding sd 130'. 64 days to drill. Deepest prod. in Calif.
15,400 D&A	Standard Calif. et al Arundell #4	Co. rig	Fillmore area Ventura	3-28-60 6-24-60				WC. 84 days to drill.
16,915 D&A	Shell Oil Sharp #1	Co. Rig #23	E. Montalvo Ventura	3-11-60 8- 8-60	Water base emul. mud.			WC. 147 days to drill. Approx. 200 bits.
			FLORIDA					
15,294 D&A	Gulf Oil et al Marquesas Blk. 28-1	Offshore Co.	Marquesas-Tortugas Monroe (Offshore)	1-16-60 4-27-60	Aerated sea water 0-10,057'; native Gyp 10,057-TD			WC. 97 days to drill. 74 bits.
			LOUISIANA					
15,000 D&A	Calif. Co. #1 Ver. Sch. Bd.	Power Rig Drlg Co.	North Leroy Vermilion	5- 3-60 8-19-60	Gyp-Q-Broxin			WC. 102 days to drill. 40 bits.
15,000 D&A	Union Oil (Cal.) #B-1 LaTerre	Gracey-Hellums	N. Lake Pagie Terrebonne	10-23-60 12-12-60	Native to 9,000'; red to 12,000'; Gyp to TD.			WC. 40 days to drill.
15,000 D&A	Miss. River Fuel, et al #L-1 LL & E		E. Bayou Perchant Terrebonne	2- 2-60 4-18-60				WC.
15,005 D&A	Superior Oil #A-5 St. Lse. 3057	Co. tools & Bay Drlg.	Lac Blanc Vermilion	5-28-60 8-22-60	18.5# @ 15,005'			FW. TA then drld. from 13,811' to TD. 167 days to drill. 75 bits.
15,008 TA	Union Oil Calif. LL & E #W-1	Webster Drlg Co.	N. Lake Pagie Terrebonne	5-29-60 8-16-60	Native to 12,100'. Gyp-oil to TD.			WC. Potential gas well. 52 days to drill. 44 bits.
15,025 TA	Texaco #1 St. Lse 3278		E. Lk. Barre Terrebonne	9-12-59 1-10-60				WC.
15,050 14,758	Sun Oil #51 Belle Isle Corp.	Co. tools	Belle Isle St. Mary	8-16-59 2-17-60	Lime-treated oil emul.	14,722-58	121 b/d 35.5° 451 mcf $\frac{7}{64}$" TP 8250	FWC. Disc. new "Q"-1 sd. 13' 72 days to drill. 45 bits.
15,050 14,750	Texaco #4 St. Lse. 2856		Caillou Island Terrebonne	12-10-59 2-19-60		14,732-50	76 b/d 41° 212 mcf S-45-TP 200	FW.
15,082 P&A	Shell Oil #2 OCS-0603	Blue Water Drlg. Corp.	S. Timbalier Blk. 76 Terrebonne	2-24-60 3-21-60	10.6#/gal. max.; low pH			WC. 19 days to drill. 18 bits.
15,100 13,938	Sun Oil #3 Belle Isle Unit 3		Belle Isle St. Mary	9-25-60 12-21-60		13,926-38	184 b/d 31.6° 151 mcf $\frac{5}{64}$" TP 1625, CP 1200, BHP 6500	FW. T-1 sd. (Orig. loc. #B-3 St. Mary Land Co.)
15,100 12,998	Humble, Miami Corp. #E-15	Co. Rig #33	Bayou Sale St. Mary	5- 1-60 7-14-60	Gyp-Q-Broxin. 13.2#/gal. max.	12,998	99 b/d 47.5° 3395 mcf $\frac{16}{64}$" TP 4600	FWC. Ext. fld. Miocene sd. 27' 62 days to drill.

TABLE 7. DESCRIPTION OF WELLS IN THE UNITED STATES DRILLED 15,000 FT AND BELOW — (continued)

1. TD, ft 2. Prod. depth(s)	Company well	Drilled by	1. Field or area 2. County/parish	1. Spudded 2. Completed	Mud program	Perfs. ft.	Initial prod./d, gravity, coke, tubing pressure.	Remarks
			LOUISIANA — (continued)					
15,100 13,992 13,874	Texaco #10 BSE Unit 2		Bay St. Elaine Terrebonne	2- 1-60 5-19-60		13,974-92 13,864-74	208 b/d 30.8° 188 mcf S-25 TP 3400 320 b/d 31.3° 380 mcf S-31 TP 2700	FW. Dual oil.
15,100 13,445	Texaco #24 St. Lse 340		Belle Isle St. Mary	1-23-60 7-27-60		13,455	156 b/d 34° 204 mcf $\frac{5}{64}$" TP 2850	FW.
15,102 14,938	Superior Oil #8 Rockefeller SL 2039	Co. tools	Constance Bayou Cameron	9-12-60 12- 4-60	11.8# at 15,102	14,922-38	108 b/d 46.3° 2988 mcf $\frac{12}{64}$" TP 4276	FWC. Ext. fld. #75 sd. 65'. 59 days to drill. 48 bits.
15,109 14,862	Shell-Conoco #4 Gall Unit 1	Co. tools	Weeks Is. Iberia	9- 7-60 10- 9-60	10.6# max.; low pH, oil emul.	14,805-62	477 b/d 47.9° 8653 mcf TP 4350	FW. Miocene sd. 27 days to drill. 36 bits.
15,116 14,824	Humble, St. Lse. 1452 LR-4	Co. Rig #39	Lake Raccourci Lafourche	9-22-59 2- 5-60	Gyp-Q-Broxin 16.8# max.	14,824	14,700 mcf $\frac{8}{8}$" TP 4500	FWC. Ext. fld. New sd. Miocene 48'. 63 days to drill
15,121 15,000	Gulf Oil, St. Lse. 3328 #2	Gulf Marine Drlg Inc.	West Delta Blk 27 Plaquemines	12-17-59 2- 4-60	Gyp-Q-Broxin	15,000		FW. 47 days to drill. 43 bits.
15,158 12,214	Calif. Co, E.P. Brady #4, St. 706 Unit 4	Brewster-Bartle	Bayou de Fleur Plaquemines	7- 5-58 11-10-60		12,202-14	87 b/d 28.6 API 425 mcf $\frac{16}{32}$" 1850 PUI	WC. Disc. Formerly E. P. Brady et al #1
15,167 D&A	Union Prod. #1 Beaugh	Bullard Drlg Co.	Branch Acadia	12-31-59 4-20-60	Gyp-Q-Broxin			FW. N. extension. 97 days to drill.
15,175 D&A	Texaco #1 Chitimacha Tribe		Charenton St. Mary	6-28-60 11-30-60				FW.
15,180 11,079	Calif. Co. #1 Placide Weekley	Power Rig Drlg Co.	Riceville Vermilion	11- 6-59 4-27-60	Gyp-Q-Broxin	11,070-79	73 b/d 48.8° 1410 mcf $\frac{5}{64}$" TP 5350	WC. New gas pay. 89 days to drill. 47 bits.
15,200 D&A	Pano Tech. #1 St. Martin Sch. Bd.	M. A. Smith Drlg. Co.	WC. St. Martin	3-1 -60 6- 9-60	Gyp, 18.3# max.			WC. 101 days to drill. 36 bits.
15,200 TA	Texaco #1 BSE Unit 8		Bay St. Elaine Terrebonne	4-25-60 9-6-60				FW. PB 13,950
15,200 15,028	Texaco #5 St. Lse. 2856		Caillou Island Terrebonne	6-29-60 8-21-60		14,997-5,028	210 b/d 36.7° 198 mcf S-30 TP 2700	FW.
15,207 13,574	Texaco #19 St. Lse. 340-EC'BB		Bayou Sale St. Mary	12-17-59 4-25-60		13,557-74	315 b/d 32.9° 227 mcf $\frac{18}{64}$" TP 1125	FW. Dual oil.
15,222 D&A	Placid Oil, LL&E "E" #2	Penrod Drlg. Co.	Lake Washington Plaquemines	9-13-60 11- 1-60				FW. 40 days to drill. 36 bits.
15,225 TA	Texaco #3 Lake Pelto Unit 11		Lake Pelto Terrebonne	6- 3-60 11- 8-60				FW.
15,233 D&A	Ocean Drlg. & Exp. #1 OCS-0585		SS Blk 138 Terrebonne	1- 1-60 2- 1-60				WC. Ship Shoal
15,234 15,008	Shell Oil #5 OCS-0587	Blue Water Drlg Corp.	SS Blk 139 Terrebonne	5-12-60 10-26-60	11.8# max.; low pH, oil emul.	14,980-15,008 (oil) 14,546-90 (gas)	384 b/d 33.7° 405 mcf $\frac{18}{64}$" TP 3100 427 b/d 61° 6800 mcf $\frac{16}{64}$" TP 5100	FW. Dual oil & gas. Miocene sd. 22 days. 20 bits.
15,249 6914	Texaco #3 Mary S. Nelson-LL&E		Point Aufer Terrebonne	3- 5-60 7-30-60		6,900-02 6,912-14	Shut-in	FW. No gage.
15,250 D&A	Humble, Ridgefield Sd. GU 8#1	Co. Rig #36	Thibodaux Lafourche	7- 6-60 11-22-60	Gyp-Q-Broxin oil emul. 17.8#/gal. max.			FW. 111 days to drill.
15,250 14,432	Texaco et al #1 Alson-Mitchell	Webster Drlg Co.	Grome Is. Vermilion	8-18-59 1- 4-60		14,422-32	269 b/d 51° 3,076 mcf $\frac{5}{64}$" TP 5280	FW.
15,253 15,044	Texaco #42 St. Lse. 1249		Caillou Is. Terrebonne	1-10-60 3- 4-60		15,008-44	226 b/d 36.4° 548 mcf S-32 TP 2575	FW.
15,278 15,116	Calif. Co., C.H. Wright 2 Unit 2-#1	Power Rig Drlg Co.	So. Mermentau Acadia	5-24-59 1- 8-60	Gyp-Q-Broxin	15,085-116	320 b/d 53.2 API 4200 mcf $\frac{20}{64}$" 4400	WC. New gas pay. 101 days to drill. 55 bits.
15,294 14,494 13,213	Texaco #20 Lk Pelto Unit 5		Pelto Terrebonne	11- 4-59 3- 2-60		14,484-94 13,194-213	180 b/d 32.7° 320 mcf S-26 TP 4350 216 b/d 39.9° 216 mcf S-29.5 TP 1950.	FW. Dual oil.
15,294 12,666	Sohio #1 Hubert Simons et al	Falcon-Seaboard	Lasinade Vermilion	4-25-60 7-23-60	Gyp base below 7500'	12,654-66	382 b/d 49.3° 1600 mcf $\frac{5}{64}$" TP 7900	WC. New gas pay. Heterostegina sd. 19', 80 days to drill. 49 bits.
15,306 14,213	Humble, E. F. Marin #6	Co. Rig 24	Bayou Sale St. Mary	12-19-59 9-11-60	Gyp-Q-Broxin oil emul. max. 12.6#	3 zones 14,213 and below	187 b/d 35.8° 368 mcf $\frac{18}{64}$" TP 1700 157 b/d 33.1° 216 mcf $\frac{18}{64}$" TP 975 227 b/d 32.2° 300 mcf $\frac{5}{8}$ TP 2200	FWC. Ext. fld. Miocene sd 85'.
15,310 D&A	Placid Oil et al #E-1 LL&E	Penrod	Lake Washington Plaquemines	7-19-60 8-26-60				WC. 34 days to drill. 29 bits.
15,310 TA	Texaco, #1 St., Comegys et al.		Grand Lk Cameron	1-29-60 7-23-60				WC.
15,311 D&A	Texaco #1 OCS-0581		Eugene Is. Blk208 St. Mary	5-15-60 8-31-60				FW. Offshore.
15,320 D&A	Placid Oil, Duval Unit 13, #1	Penrod Drlg Co.	Lapeyrouse Terrebonne	10- 3-60 12-21-60				FW. D&A. 39 days to drill. 44 bits.
15,330 14,048	Kilroy Co. #B-1 Mellhenry Est.	Loffland Bros.	Buck Point Vermilion	6- 1-60 10- 2-60	13.5#-13.500; 14.5#-14,500; 15.1#-15,335.	14,003-48	140 b/d $\frac{12}{64}$" ch TP 3900.	FW. Gas. 65 rock and 2 diamond bits.

TABLE 7. DESCRIPTION OF WELLS IN THE UNITED STATES DRILLED 15,000 FT AND BELOW — (continued)

1. TD, ft 2. Prod. depth(s)	Company well	Drilled by	1. Field or area 2. County/parish	1. Spudded 2. Completed	Mud program	Perfs. ft.	Initial prod/d, gravity, coke, tubing pressure.	Remarks
			LOUISIANA — (continued)					
15,337	Texaco #15-A BSE Unit 2	Brewster-Bartle	Bay St. Elaine Terrebonne	9-18-60 12-18-60		14,800-10	195 b/d 30.5° 366 mcf S-23 TP 4600	FW.
15,350 15,210	Texaco #13 Lk Barre Unit 38		Lake Barre Terrebonne	10- 5-60 11-14-60		15,194-210	224 b/d 32.3° 217 mcf S-27 TP 2950	FW.
15,351 D&A	Texaco #1 J. J. Hebert, et al		Bateman Lk St. Mary	6-16-60 11- 3-60				FWC. West extension.
15,384 15,130	Pan Am. #9 Buras Lev. Dist.		Bastian Bay Plaquemines	1-21-60 4-15-60		15,048-130	120 b/d 41.6° 6700 mcf 14/64" TP 6000	FW. Dual gas.
15,407 D&A	Gen'l Crude Oil et al #1 Chas. H. Fox	Owen Drlg Co.	WC. Jefferson Davis	11- 1-59 5-19-60	Native low pH; Gyp-Q-Broxin; 16.6#			WC. 147 days. 78 bits. Midwest took over, 5-5-60.
15,415 D&A	Hamie Hunt Tr. #Randolph Parro	Penrod Drlg Co.	Thibodaux Lafourche	3-12-60 5-14-60	Gyp base mud.			FW. 52 days to drill. 33 bits.
15,424 15,006	Quintana #2 Plantation Refg.	Sharp-Gulf Drlg Co.	Garden City St. Mary	11- 8-59 2- 8-60	Gyp oil emul.	14,996-15,006	5000 mcf Pres. 10,800# C I	FW. 90 days to drill.
15,470 15,032	Shell Oil #1 OCS-0588	Dixilyn Drlg Co.	Ship Shoal Blk139 Terrebonne	11-17-59 1- 4-60	11.5#/gal. low pH.	15,016-32	420 b/d 37.6° 620 mcf 18/64" FTP 3000	WC. Miocene sd. 31 days to drill. 31 bits.
15,471 15,325	Union Prod. #C-2 La Terre Co.	Brewster-Bartle	Dulac (Conf) Terrebonne	12-30-59 4- 5-60	Gyp	15,299-325	130.5 b/d 50.9° 4500 mcf 12/64" TP 5700	FWC. Conf. Miocene sd. 83 days to drill.
15,475 15,200	Gulf Oil, #11 St. Lse. 2869	Gulf Marine Drlg Co.	W. Delta Blk 27 Plaquemines	3-14-60 11-15-60	Gyp-Q-Broxin	15,178-200	505 b/d 47.7° 9700 mcf 18/64"	FWC. Offshore. Gas disc. 55 days to drill. 57 bits.
15,477 D&A	Pet. Offshore Lsehds. #1 OCS-0471	Offshore Co. Rig #52	Eugene Is Blk 184 St. Mary	5-16-60 8-12-60	T-8			FW. Offshore. 38 bits.
15,478 D&A	John W. Mecom, #G-1 LL&E	Cron & Gracey	Bay St. Elaine Terrebonne	10-14-59 3- 4-60				WC. 27 bits.
15,488 14,712 15,020	John W. Mecom, #6 LL&E	Co. tools	Lk Washington Plaquemines	2-26-60 7- 1-60		14,678-712 15,008-20	51 b/d 33.8° 4158 mcf 32/64" TP 125/3869	FW. Dual gas-oil. 73 days to drill.
15,500 11,628	Gulf Oil, St. Lse. 1423, #17 & 17-D	Kerr-McGee Drlg Co.	Timbalier Bay Blk 21 Lafourche	12-31-59 2-24-60	Gyp-Q-Broxin	11,372 11,628	313 b/d 27.9° 352 mcf 7/64" TP 4117 333 b/d 26.0° 577 mcf 1/8 TP 4300	FWC. Ext. D-10 sd. 8'. D-12 sd. 47'. 56 days to drill. 34 bits.
15,500 D&A	Humble Oil, St. Lse. 3512 #1	Southeastern Drlg.	Blk 6 Vermilion	2-29-60 7- 7-60	Gyp-Q-Broxin oil emul. 17.7# maximum			WC. 104 days to drill.
15,500 12,770	Gulf Oil, St. "PP" Well #1	Rimrock Tidelands	W. Delta Blk 27 Plaquemines	5- 1-60 7-15-60	Gyp-Q-Broxin	12,680-770	72 b/d 54.1° 2221 mcf 16/64" TP 4500	FW. 69 days to drill. 57 bits.
15,500 15,044	Gulf Oil, St. Lse. 3529, #1	Rimrock Tidelands	W. Delta Blk 27 Plaquemines	2-23-60 4-17-60	Gyp-Q-Broxin	15,024-44	90 b/d 47.1° 2460 mcf 5/64" TP 5900	FW. 49 days to drill. 36 bits.
15,500 14,059	Gulf Oil, St. "PP" #54	Producers Drlg. Co.	West Bay Plaquemines	5-31-60 8- 4-60	Gyp-Q-Broxin from 8000'	14,059	262 b/d 38.7° 346 mcf 7/64" TP 8150	WC. New sd 36'. 54 days to drill. 31 bits.
15,500 D&A	Shell Oil, #1 OCS-0695	Brewster-Bartle	Eugene Is. Blk 7 Iberia	9-24-60 1-20-60	18# max; low pH, gyp			WC. 118 days to drill. 46 bits.
15,500 15,124	Texaco, #10 Unit 38		Lk Barre Terrebonne	1-17-60 3-31-60		15,108-24	216 b/d 31.4° 211 mcf S-30 TP 2300	FW.
15,520 14,492	Texaco et al #1 Armel Landry, Unit 5		Grosse Is. Vermilion	3-16-60 6-28-60		14,476-92	360 b/d 51.6° 3000 mcf 5/64" TP 9000	FW.
15,502 15,232	Humble Oil, La Terre Co. D-7	Co. Rig 39	Bayou Jean la Croix Terrebonne	2- 8-60 5- 3-60	Gyp-Q-Broxin oil emul. 17.9# max.	15,232	345 b/d 45.8° 3015 mcf 5/64" CP 800	FWC. Ext. fld. New Miocene sd. 18'. 71 days to drill.
15,525 14,855	Union Prod., #1 Harry Bourg	Brewster-Bartle	Bayou Rambo Terrebonne	1-13-60 4-23-60	Gyp	14,815-55	3700 mcf 12/64" TP 5000	FWC. Miocene sd. 82 days to drill.
15,538 D&A	San Jacinto O & G, Angeron #1	C. B. Webster	WC. Terrebonne	1960				WC.
15,555 D&A	Union Oil (Cal.) #1 St. Lse. 3484	Dixie Drlg Co..	Koch's Ridge Vermilion	2-20-60 5-17-60	Low pH red oil emul. Gyp from 12,804'.			WC. 84 days to drill. 58 bits.
15,581 D&A	Union Texas Nat'l Gas. #1 U. Hebert	C B. Webster	Abbeville Vermilion	1- 3-60 4-26-60	18# max. wgt. to TD			WC. 90 days to drill. 48 bits.
15,590 P&A	Superior, #1 BLM-OCS-0525	Kerr-McGee Drlg. Co.	W. Cameron Blk 71 Cameron	2-17-60 7-26-60				FWC. Offshore. 139 days to drill. 78 bits.
15,595 15,156	Gulf Oil, St. Lse. 3528, #3	Rimrock Tidelands	W. Delta Blk 27 Plaquemines	9- 8-60 11- 9-60	Caustic & Unical	15,084-156	192 b/d 45.9° 5013 mcf 13/64" TP 6260	FW. 57 days to drill. 49 bits.
15,600 11,640	Kerr-McGee, #K-1 OCS-0346	Co. tools	Ship Shoal Blk 28 Terrebonne	3- 1-60 8-27-60	Gypsum- oil emul.	11,577-640	322 b/d 58° (Est.) 9372 mcf 28/64" FP 3300	FWC. Offshore. Ext. fld. Mio. sd 37'. 153 days. 93 bits. Selective completion.
15,602 15,041	Shell Oil #3 OCS-0588	Blue Water Drlg. Corp.	Ship Shoal Blk 139 Terrebonne	3-21-60 5-10-60-	12# max.; low pH, oil emul.	15,026-41	296 b/d 35.7° 410 mcf 5/64" FTP 3050psi	FW. Offshore. Miocene sd. 37 days to drill. 25 bits.
15,606 14,877	Gulf Oil, #75 St. Lse. 1772	Falcon Seaboard	Timbalier Bay Lafourche	2-14-60 4-27-60	Gyp-Q-Broxin	14,877	244 b/d 46° 2281 mcf 5/64" TP 7200	FWC. New sd D-34 10'. 56 days. 48 bits.
15,607 12,823	J. Ray McDermott #C-1 OCS-0526		W. Cameron Blk 68 Cameron	11-20-59 2- 9-60		12,813-23	81 b/d 48° 2500 mcf 18/64" TP 4550	FW. Offshore "C" sd. 70 days. 82 bits.
15,628 13,580	Quintana Pet. #2 Williams	Sharp Gulf	Garden City St. Mary	3- 2-60 6-11-60	Gyp. oil emul.	13,570-80	3500 mcf 5/64" TP 3550	FWC. So. ext. 90 days to drill.

TABLE 7. DESCRIPTION OF WELLS IN THE UNITED STATES DRILLED 15,000 FT AND BELOW — (continued)

1. TD, ft 2. Prod. depth(s)	Company well	Drilled by	1. Field or area 2. County/parish	1. Spudded 2. Completed	Mud program	Perfs. ft.	Initial prod/d, gravity, coke, tubing pressure.	Remarks
			LOUISIANA — (continued)					
15,630 15,420	Grande Corp. #3 Sand Unit C #1	Co. tools	St. John Lafourche	11-19-60 3- 3-60		15,396-420	225 b/d 47.5° 3192 mcf 14/64" TP 2350	FWC. Ext. fld. Operc. #3 sd 25'. 81 days to drill.
15,650 14,849	Shoreline Expl. #2 St. Lse. 3320		So. Lake Sand Iberia	1- 9-60 6-14-60	Red mud. Gyp after 9000'	14,843-49	134 b/d 54.8° 2500 mcf 5/64" TP 8650	WC. Disc. Well Offshore.
15,650 D&A	Placid Oil #1 OCS-0803	Penrod Drlg. Co.	Eugene Is. Blk198 St. Mary	6- 3-60 7-28-60				WC. Offshore. 51 days to drill. 32 bits.
15,650 D&A	Shell Oil #6 OCS-0587	Blue Water Drlg. Corp.	Ship Shoal Blk 139 Terrebonne	7-24-60 8-26-60	11# max.; low pH, oil emul.			WC. Offshore. 34 days to drill. 26 bits.
15,653 15,616	Pan Am. Pet. #1 St. Lse. 3599	Dixie Drlg. Co.	Lk Raccourci Lafourche	9- 1-60 11-12-60		15,606-16		WC. Gas. disc.
15,653 15,160	Gulf Oil St. "PP" 192, #2	Rimrock Tidelands	W. Delta Blk 27 Plaquemines	7-16-60 9- 7-60	Unical & caustic	15,120-60	228 b/d 46.5° 6225 mcf 15/64" TP 6127	FW. 46 days to drill. 41 bits.
15,662 13,580	Quintana #2 McPherson-Wesslund	Gracey-Hellums	Garden City St. Mary	1960	Gyp oil emul.	13,570-80	5000 mcf	FW. Gas. 70 days to drill.
15,663 13,122	Placid Oil #2 OCS-0436	Penrod Drlg. Co.	Eugene Is. Blk198 St. Mary	4-11-60 6- 2-60		13,098-122	245 b/d 44.5° 4000 mcf 14/64" SITP 5650 FP 4500	FWC. Offshore. F-3 sd. 40 days to drill. 33 bits.
15,700 D&A	Calif. Co. #1 C. A. Brewer, Jr.	Loffland Bros.	Flamingo Cross. Acadia	3-23-60 8-16-60	Gyp-Q-Broxin			WC. 134 days to drill. 62 bits.
15,731 13,249	Humble Oil M. J. Foster #2	Co. tools Rig 53	Bayou Sale St. Mary	11- 8-59 2-25-60	Gyp-Q-Broxin oil emul. 13.3# max.	13,249	260 b/d 33.2° 264 mcf 1/8" TP 2200	FWC. Ext. fld. Miocene sd. 46'. 91 days to drill.
15,735 D&A	Gulf Oil St. Lse. 3453 #1	Dixie Drlg. Co.	Redfish Point Vermilion	2-24-60 5- 4-60	Gyp-Q-Broxin			WC. 70 days to drill. 67 bits.
15,737 11,616	Humble Oil, La Terre Co. D-8	Co. Rig 45	Bayou Jean La Croix Terrebonne	7-28-60 11-18-60	Gyp-Q-Broxin oil emul. 17.5# max.	11,616	216 b/d 38° 1080 mcf 1/8" TP 3850	FWC. Ext. fld. Miocene sd 11'. Orig. hole. 71 days. St. #1, 30 days.
15,738 15,270	F. A. Callery #1 Bureau Ld. Mgmt.	Hershey Drlg. Co.	Bastian Bay Plaquemines	5- 8-60 8- 5-60	Gyp-Q-Broxin	15,256-70	100 b/d 44° 4700 mcf 14/64" TP 5000 132 b/d 44° 5910 mcf 15/64" TP 5600	FWC. Dual gas ext. Miocene sd. 72 days. 47 bits.
15,758 13,904	Texaco #13 Lk Barre Unit 34		Lake Barre Terrebonne	4-21-60 9-11-60		13,894-904 13,217-237	162 b/d 27.8° 154 mcf S-35 TP 1400 168 b/d 32.1° TP 700.	FW. Dual oil.
15,759 15,668	Shell #1 "V" Sd. Oil Unit "A"	Co. tools	Weeks Is. Iberia	10-16-60 11-23-60	10.8#/gal. max.; low pH; oil emul.	15,656-68	244 b/d 38.7° 226 mcf 19/64" TP 1700	FW. Miocene sd. 31 days to drill. 44 bits.
15,766 14,764	Texaco #38 St. Lse. 340-CB1		Cote Blanche Isl St. Mary	6-18-60 10-14-60		14,752-64	193 b/d 29.7° 3/64" TP 145	FW.
15,770 D&A	Humble Lutcher Moore Lbr. #5	Co. Rig #36	Chacahoula Bayou Terrebonne	11-14-59 4- 9-60	Gyp-Q-Broxin. Oil emul. 20.2#/max.			WC. 113 days to drill.
15,781 D&A	Shell Oil #2 OCS-0588	Ocean Drlg. & Exp. Co.	Ship Shoal Blk 139 Terrebonne	2- 4-60 3- 9-60	10.6#/max.; low pH.			FW. 35 days to drill. 26 bits.
15,800 P&A	Texaco #1 C.C. Derouen Unit 7		Grosse Is. Vermilion	12-18-59 4- 2-60				FWC. North flank.
15,804 15,772	Texaco #1 Lk. Barre Unit 47		Lake Barre Terrebonne	6-15-60 7-22-60		15,766-72	201 b/d 43° 1501 S-32 TP 3500	FW.
15,850 15,802	Texaco #2 Lk. Barre Unit 46		Lake Barre Terrebonne	11-16-59 2- 8-60		15,780-802	200 b/d 42.6° 1447 mcf S-32.5 TP 4100	FW.
15,856 14,732	Tenn. Gas Trans. #1-A Luke Detraz	Yates	South Abbeville Vermilion	7-21-60 11-18-60		14,716-32	185 b/d 46.8° 4900 mcf 13/64" TP 5585	WC. Disc. A-1 sd. 30'. Re-drilled from 13,146'. to 15,856. Cleaned out to 13,146.
15,864 15,642	Shell #1 Weeks-Gall Unit 7	Co. tools	Weeks Is. Iberia	1-18-60 3-25-60	11.1#/max.; low pH, oil emul.	15,629-642	300 b/d 29.8° 310 mcf 18/64" TP 1100	FW. Miocene sd. 46 days to drill. 57 bits.
15,879 11,495	Texaco #79 La Terre Co., Inc.		Golden Meadow Lafourche	1- 3-60 5-18-60		11,485-95	182 b/d 34.2° 1293 mcf S-26 TP 2500	FW.
15,880 D&A	Union Oil Cal. St. Lse. 3566	C.B. Webster Drlg. Co.	S. Redfish Point Vermilion	9-16-60 1- 2-61	Gyp-Q-Broxin. oil emul.			WC. 104 days to drill. 88 bits.
15,880 D&A	Austral Oil #B-1 La Furs, Inc.	C.B. Webster Drlg. Co.	N. Fresh water Bayou Vermilion	9-14-59 2-14-60	Natural to 10,000'. Gyp-Q-Broxin to TD.			WC. 145 days to drill. 98 bits.
15,880 15,743	Placid #1 Duval Unit #11	Penrod Drlg. Co.	Lapeyrouse Terrebonne	4-18-60 6-26-60		15,660-743	Shut-in.	FWC. Gas dist. Duval sd. 57 days 63 bits. Formerly #B-1 La Terre.
15,893 D&A	Humble A. Stockstill B-1	Co. Rig 29	N. Bayou Boutte St. Martin	10-30-59 1- 7-60	Gyp-Q-Broxin. Oil emul. 17.2#/max.			FWC. 84 days to drill.
15,936 14,442	Superior #14 St. Lse. 3057	Rowan Drlg. Co.	Lac Blanc Vermilion	3-16-58 5-26-60	18.6# @ TD.	14,436-42	133 b/d 43.3° 172 mcf. 29/64" TP 9580	FW. No. 73 sd. 40'. 231 days. 67 bits. Well TA in 1959.
15,962 10,794	Superior Oil OCS-0548 #1	Kerr-McGee	Blk 35, Vermilion	8-22-60 12-20-60		10,781-94	71.76 b/d 50° 3845 mcf 15/64" TP 3377	FW. offshore. VLS sd. 45'. 113 days to drill. 49 bits.
16,000 D&A	Southern Nat'l. Gas #1 Nat. As. of Audubon	Sharp Gulf Drlg. Co.	WC Vermilion	10-13-60 12-27-60	Gyp base w/oil. 18.0#/max.			WC. 64 bits.

TABLE 7. DESCRIPTION OF WELLS IN THE UNITED STATES DRILLED 15,000 FT AND BELOW — (continued)

1. TD, ft 2. Prod. depth(s)	Company well	Drilled by	1. Field or area 2. County/parish	1. Spudded 2. Completed	Mud program	Perfs. ft.	Initial prod/d, gravity, coke, tubing pressure.	Remarks
			LOUISIANA — (continued)					
16,000 P&A	Shell Oil #1 St. Lse. 3464	Co. tools	Sabine Lake Cameron	1-26-60 4-12-60				WC. 79 days to drill. 28 bits.
16,000 15,510	Texaco #54 St. Lse. 340-CBI		Cote Blanche Isle St. Mary	11-14-59 4-22-60		15,504-10	179 b/d 27° 11/64" TP 742	FW.
16,000 TA	Texaco #2 Lafourche Rlty		Bayou Ferblanc Lafourche	3- 8-60 8-15-60				FWC. Conf.
16,000 15,758	Shell #4 Gonsoulin-Minvielle St.	Loffland Bros.	Weeks Is. Iberia	3- 1-60 5- 3-60	11.0#/ low pH, oil emul.	15,704-58	195 b/d 29.5° 237 mcf 5/64" FTP 1600	FW. Miocene sd. 56 days. 55 bits.
16,000 14,492	Sun Oil #7 Belle Isle Unit 1	Co. tools	Belle Isle St. Mary	4-15-60 11-13-60	Gyp-treated oil emul.	14,478-92	162 b/d 33.6° 175 mcf 2" op. ch. TP 100	FW. "P" sd. 14'. 138 days to drill. 89 bits.
16,000 14,955	J. Ray McDermott #C-1 OCS-0265	Offshore Co.	W. Cameron Blk 33 Cameron	10- 9-59 3-23-60	Phosphate-10.5# to 8000'. Gyp oil emul-11.5#-18.5# TD	14,940-55	135 b/d 38° 4500 mcf 18/64" TP 8200	FW. offshore. "C" sd. 124 days to drill. 90 bits.
16,000 16,000	Shell Oil #7 OCS-0587	Blue Water Drlg. Corp.	Ship Shoal Blk 139 Terrebonne	8-25-60 10-15-60	16.9# max.; low pH, oil emul.	Unpref.		FW. offshore. 48 days to drill. 27 bits.
16,020 D&A	Sinclair O&G #1 OCS-0833	Dixilyn Drlg. Co.	S. Timbalier Blk 77 Terrebonne	4-16-60 6-13-60	Sea-water gyp to 8500; Fresh water gyp to TD			WC. Offshore. 59 days to drill. 36 bits.
16,050 16,010	Texaco #3 Lk Barre Unit 46		Lake Barre Terrebonne	2- 9-60 5- 4-60		15,994-16,010	228 b/d 26.9° 116 mcf S-32 TP 1550	FW.
16,092 15,897	Union Prod. #7 St. Lse. 2340- Rkflr.	Brewster-Bartle	Deep Lake Cameron	5-11-60 11- 2-60	Gyp	15,883-97	37 b/d 2500 mcf 14/64" TP 2590	FW. 124 days to drill. Miocene sd.
16,100 15,909	Texaco #179 St. Caillou Is.		Caillou Is. Terrebonne	7-22-60 12-30-60		15,888-909	205 b/d 29.9° 404 mcf S-29 TP 325	FW.
16,107 D&A	Tidewater Oil #1 St. Lse. 192		Bastian Bay Plaquemines	8-26-60 12- 6-60				FW.
16,118 16,070	Placid Oil Duval Unit 9-#1	Penrod Drlg. Co.	Lapeyrouse Terrebonne	12-26-59 3- 2-60		16,050-70	185 b/d 50.1° 4911 mcf 16/64" TP 3900	FW. Duval sd. 61 days. 62 bits. Former #1 Marie Wurzlow Unit 3.
16,135 15,936	Superior Oil #6 LL&E Unit 19	Co. tools	Four Isle Terrebonne	2-29-60 6- 6-60	17.2# @ 16,135'	15,896-936	63 b/d 49.1° 3982 mcf 13/64" TP 5570	FW. 86 sd. 35'. 93 days to drill. 62 bits.
16,157 15,981	Texaco #4 St. LL&E Unit 3		Caillou Is. Terrebonne	12-15-59 7-19-60		15,970-81	228 b/d 41.8° 2017 mcf S-37 TP 5000	FW.
16,162 14,568 13,580	Placid Oil #2 C. W. Boughman	Penrod Drlg. Co.	Patterson St. Mary	11- 6-59 3- 2-60		14,554-68 13,550-80	Gas: 43.34 b/d 39.5° 3,100/mcf 11/64" TP 4000 Oil: 230 b/d 34° 200 mcf 5/64" TP 2000.	FW. Dual gas & oil. Deseorlies B-2-gas. Cristellaria A-1, oil. 85 days. 65 bits.
16,170 15,588	Superior Oil #1 LL&E Co. Unit 20	Co. tools	Four Isle Terrebonne	6-10-60 9-25-60	16.5# mud @ 16,170'.	15,568-88	38.36 b/d 48.2° 3954 mcf 15/64" TP 3500	FW. 84 sd. 25'. 89 days to drill. 67 bits.
16,200 D&A	Sunray Mid-Cont. #1 St. Lse. 3487	C.B. Webster Drlg. Co.	E. Cote Blanche Iberia	2-28-60 8- 4-60	Magcobar			WC. 161 days to drill. 121 bits.
16,225 14,433 13,500	Placid Oil #1 Spencer G. Todd	Fred Wilson Drlg. Co.	Patterson St. Mary	1-21-60 5- 1-60		14,407-33 13,480-500	Shut-in. No gage.	FW. Dual gas & oil. Gas, Discorlien B-2 sd. Oil, Cristellaria A-1 sd. 78 days. 44 bits.
16,255 14,739	Texaco #224 LL&E-Leeville		Leeville Lafourche	1-22-60 7-14-60		14,735-739	182 b/d 26.5° 592 mcf 8/64" TP 300	FW.
16,300 D&A	Calif. Co., A. LeBlanc Unit 3-1	Circle Drlg. Co.	S. Mermentau Acadia	2- 4-60 8-28-60	Gyp-Q-Broxin			FW. 129 days to drill. 47 bits.
16,302 15,063	Pan Am. Pet. C-2 C.E. Gheens		Raceland Lafourche	2-16-60 7-19-60		14,974-15,063	262 b/d 35.8° 3500 mcf 5/64" TP 8000	WC. Disc. new gas field.
16,320 11,340 11,144	General Crude #1 Miami Corp.	Edwards Drlg. Co.	Little Pecan Lk Cameron	10- 5-59 6- 6-60	Native-low pH, Gyp-Q-Broxin	11,328-40 11,130-44	60 b/d 47.9° 4760 mcf 15/64" TP 3665 72 b/d 42.1° 5878 mcf 15/64".	WC. W. flank. Dual SI-gas. Cristellaria #3 sd. 23'. Cristellaria #2 sd. 20'. 204 days. 82 bits.
16,331 P&A	Davis S. Thayer #1 Dr. M. O. Miller	Loffland Bros.	WC Vermilion	8-12-59 1-26-60				WC.
16,347 16,210	John W. Mecom #1 L. I. Lapeyrouse	Co. tools	Lapeyrouse Terrebonne	10-25-59 2-16-60		16,190-210	311 b/d 49° 5125 mcf 15/64" TP 4300 168 b/d 52° 5291 mcf 15/64" TP 3600	FW. Dual gas. 103 days to drill. 87 bits.
16,386 P&A	Superior Oil #1 St. Lse. 3594	Co. tools	Atchafalaya Bay St. Mary	12- 8-59 3-21-60	17.5# @ TD			WC. 93 days to drill. 43 bits.
16,431 13,891	Humble Miami Corp "E" #12	Co. Rig #33	Bayou Sale St. Mary	9- 4-59 2-18-60	Gyp-Q-Broxin Oil emul. 14.2# max.	13,891	240 b/d 31.9° 223 mcf 1/2" TP 2500	F WC. Ext. fld.-new sd. Miocene 8'. 93 days.
16,465 16,325	Sun Oil #4 St. Lse. 2626	Brewster-Bartle	Lake Pelto Terrebonne	10-14-59 3-10-60	Lime-treated oil emul.	16,320-325/20	308 b/d 34° 431 mcf 5/64" TP 3650	FW. Directional re-drill "R" sd. 5'.
16,500 D&A	Mobil #1 Gradish Johnson	Co. tools	WC Plaquemines	2-12-60 5-31-60				WC days to drill.
16,500 D&A	Humble Oil, St. Lse. 3510 #1	Southeastern Drlg. Co.	Vermilion Blk 8 Vermilion	9-18-59 6-29-60	Gyp-Q-Broxin Oil emul. 18.8# max.			WC. Offshore.
16,500	Texaco, Thibodaux #1	C.B. Webster Drlg. Co.	WC St. Martin	1960				WC.

TABLE 7. DESCRIPTION OF WELLS IN THE UNITED STATES DRILLED 15,000 FT AND BELOW — (continued)

1. TD, ft 2. Prod. depth(s)	Company well	Drilled by	1. Field or area 2. County/parish	1. Spudded 2. Completed	Mud program	Perfs. ft.	Initial prod/d, gravity, coke, tubing pressure.	Remarks
			LOUISIANA — (continued)					
16,566 15,700	Placid #1 Bourg Unit 4	Penrod Drlg. Co.	Lapeyrouse Terrebonne	7- 3-60 10- 1-60		15,682-700	Shut-in. No gage TP 5300.	FW. Bourg sd. 82 days to drill. 81 bits.
16,600 D&A	Humble #1 OCS St. Lse. 818	Kerr-McGee	W. Delta Blk 27 Plaquemines	7-11-60 12-31-60	Gyp-Q-Broxin oil emul. 17.7# max.			FWC. Offshore. 161 days to drill.
16,754 Dry	J. Ray McDermott #F-1 OCS-0526		Blk 68 Cameron	9- 2-60 12- 3-60				FW. Offshore.
16,800 14,616	Texaco #12 St. Lse. 1247		Caillou Is. Terrebonne	1-12-60 6-14-60		14,597-616	240 b/d 34.9° 382 mcf S-31 TP 2150	FW.
16,802 16,149	Texaco #58 St. Lse. 340-CB1	Brewster-Bartle	Cote Blanche Is. St. Mary	6-18-60 12- 8-60		16,146-49	206 b/d 28° 82 mcf $^{16}/_{64}$" TP 777-1	FW.
16,815 D&A	H. L. Hunt #1 R. C. Platter, Jr.	Penrod Drlg. Co.	WC Terrebonne	10-25-59 3- 7-60	Gyp base			WC. 132 days to drill. 88 bits.
16,903 D&A	Union Prod. #1 LL&E	Delta Marine Drlg. Co.	WC Terrebonne	4- 7-60 8-22-60	Gyp			WC. 96 days to drill.
16,914 15,002	Hunt Oil #1 OCS-0424	Penrod Drlg. Co.	Eugene Is. Blk 77 St. Mary	8-28-59 12-23-59	Gyp Base	14,994- 15,002	8 b/d 43.5° 2400 mcf $^{12}/_{64}$" TP 2500 61 b/d 47.9° 6100 mcf $^{16}/_{64}$" TP 4300	FW. Offshore Dual. 15,000' sd 50'. 96 days. 81 bits.
16,945 D&A	Placid Oil #3 OCS-0476	Penrod Drlg. Co.	Eugene Is. Blk 198 St. Mary	7-29-60 10- 5-60				WC. Offshore. 68 days to drill. 42 bits.
16,974 Dry	Shell Oil #4 St. Lse. 2636	Rimrock-Tidelands	Lk Washington Plaquemines	11- 6-59 2- 1-60	15.5# max.; low pH. Gyp.			FWC. Outstep. 83 days to drill. 66 bits.
17,000 14,888	Texaco-Union Cal. #4 St. Lse. 3005		Leeville Lafourche	2- 9-60 7-12-60		14,868-88	259 b/d 26.6° 280 mcf S-31 TP 2400	FWC. Conf. Well Ext. fld.
17,000 16,781	Shell Oil #2 W. G. Weeks.	Co. tools	Weeks Is. Iberia	5-12-60 8-11-60	11.5# max.; low pH, oil emul.	16,753-81	240 b/d 27.2° 288 mcf $^{12}/_{64}$" FTP 1300 psi	FW. Miocene. 51 days. 71 bits. Record for open hole carried—3005' to TD. (13,995' O.H.)
17,000 SI	Sun Oil #53 Belle Isle Corp.	Co. tools	Belle Isle St. Mary	2-17-60 8- 6-60	Gyp-treated, oil emul.	Not perf.	SI-no test.	FW. Potential gas well. 79 days to drill. 54 bits.
17,020 16,362	Superior #2 Humble Fee #2	Bay Drlg. Co.	Lac Blanc Vermilion	8-25-60 12-19-60	18.6# @ TD	16,348-62	88 b/d 42.7° 8062 mcf TP 9359	FW. #77 sd. 220'. 97 days to drill. 61 bits.
17,059 TA	Texaco #1 Lk Barre Unit 11		Lake Barre Terrebonne	12-17-59 5- 5-60				FW.
17,070 16,694	Superior Oil #1 R. C. Milling	Nichlos Drlg. Co.	S. Sunrise Terrebonne	5- 6-60 9-29-60	18.6# @ TD	16,684-94	31 b/d 39.2° 5704 mcf $^{5}/_{64}$" FTP 12,200 SIP 13,300	WC. Gas disc. Krumbhar sd. 20'. 119 days. 44 bits. Record high pressure.
17,184 D&A	Trice Prod #1 Caldwell-Moresi	Bayou Drlg. Co.	Theall Vermilion	3-31-60 7-15-60	17.7# oil emul. Milflo-Q-Broxin			WC. 49 bits.
17,200 5,482	Sun Oil #1 Mailhes	Co. tools	Abbeville Vermilion	11- 9-59 3-17-60	Lime-treated oil emul.	5,475-82	5 b/d 51.3° 1002 mcf adj. chs. TP 2100	FWC. New sand-Mailhes 25'. 122 days. 58 bits.
17,209 P&A	Superior "B"-#8 La Terre Co.	Co. tools	Bayou Penchant Terrebonne	12-19-59 5-15-60	17.9# @ TD			FW. 135 days to drill. 70 bits.
17,238 D&A	Tidewater #1 B-1 Lacassine	Clegg & Hunt	Lacassine Refuge	1-30-60 4-28-60	Natural gel, 9-9.5#. to 17# Gyp mud, 9.5# to 17#			WC. 41 days to drill. 40 bits.
17,270 16,039	Placid #1 Duval Unit 12	Penrod Drlg. Co.	Lapeyrouse Terrebonne	6-26-60 10- 3-60		16,029-39	171 b/d 47.9° 3800 mcf $^{14}/_{64}$" TP 3700	FW. Duval sd. 78 days. 79 bits. Former La Terre B-2.
17,280 11,824	Sohio #1 Paula Simon-Bracquet	Grady Roper	Cossinade Vermilion	11- 6-59 7-15-60	Hi-pH lime base to 16,365'. Black Magic to TD.	11,817-24	125 b/d 46° 200 mcf $^{5}/_{64}$" TP 4775	WC. Oil disc. Discorbis sd 236'. 149 days. 67 bits. Fished for stuck drillpipe for 30 days @ 16,365'. P&A Dec. 1960.
17,291 16,067	Clegg & Hunt, #1 St. Lse. 2621	Co. tools	Lake Pelto Terrebonne	11- 2-59 4-11-60	14.5# @ 17,000'	16,057-67	372 b/d 52.9° 5173 mcf $^{12}/_{64}$" TP 4500	FWC. New sand 35'. 132 days to drill. 89 bits.
17,303 D&A	Superior #27 Rockefeller St. Lse. 2038	Co. tools	Deep Lake Cameron	3-25-60 9- 8-60	18.0# @ 17,303'			FW. West flank. 166 days. 104 bits.
17,306 16,370	Texaco #1, St. Lse. 3278		Lk. Raccourci Terrebonne	9-12-59 12- 5-60		16,363-70	54 b/d 39.8° 1297 mcf $^{7}/_{64}$" TP 5500	FWC. New gas pay. Orig. loc. filed by Gulf.
17,328 D&A	Hunt #1, Hebert-Helms Sweet Lake	Penrod Drlg. Co.	WC Cameron	11-23-59 5-17-60	Gyp base			WC. 92 days to drill. 93 bits.
17,335 D&A	Sun Oil #2 St. Agency "A"	Co. tools	Belle Isle St. Mary	12- 1-59 5-20-60	Gypsum treated oil emul.			FW. 165 days to drill. 64 bits.
17,399 15,265 14,458	Texaco #14 Lake Barre Unit 38		Lake Barre Terrebonne	5-27-60 8-21-60		15,425-65 14,448-58	250 b/d 30.4 ° 251 mcf S-275 TP 2800 252 b/d 34.6° 212 mcf S-28 TP 2200	FW. Dual oil.
17,405 D&A	Sinclair #1 E.A. McIlhenny	Thirteen Drlg. Co.	WC Vermilion	6- 5-59 11- 8-59	Fresh water-gyp			WC. 157 days to drill. 75 bits.
17,492 P&A	Superior #K-1 LL&E Unit	Bay Drlg. Co.	South Lk. Hatch Terrebonne	12-15-59 3-19-60	18.2# @ TD			WC. 95 days to drill. 42 bits.
17,500 D&A	Conoco #1 Asa Ricard	Dillard-Waltermire	Maurice Vermilion	3-16-60 6-27-60	Fresh water w/C-Q & Bentonite to 7500' M-1, O-E w/C-Q, lime & starch to TD.			FW. So. ext. 105 days to drill. 39 bits.

TABLE 7. DESCRIPTION OF WELLS IN THE UNITED STATES DRILLED 15,000 FT AND BELOW — (continued)

1. TD, ft 2. Prod. depth(s)	Company well	Drilled by	1. Field or area 2. County/parish	1. Spudded 2. Completed	Mud program	Perfs. ft.	Initial prod/d, gravity, coke, tubing pressure.	Remarks
			LOUISIANA — (continued)					
17,500 17,366	Sun Oil #A-1 St. Mary Land	Webster Drlg. Co.	Belle Isle St. Mary	10- 9-59 5-13-60	Gypsum-treated, oil emul.	17,356-66	174 b/d 44.7° 4105 mcf 19/64" TP 10,500	FWC. North ext. Rob. 43-2 sd. 50'. 140 days. 59 bits.
17,505 D&A	Union Calif. LL&E #3 St. Lse. 3088	Gracey-Hellums	Timbalier Bay Lafourche	12-21-59 3-23-60	High pH T-8 oil emul.			WC. 83 days to drill. 50 bits.
17,520 17,352	Texaco #3 Lk. Barre Unit 44		Lake Barre Terrebonne	5-10-60 8-21-60		17,234-352	302 b/d 34° 513 mcf S-31 TP 3000	FW.
17,530 J&A	E. Cockrell Jr. #1 M. Cyr et al	Loffland Bros.	Patterson St. Mary	3-26-59 2-15-60				FW. Well blew out—burned.
17,800 12,680	Superior #A-18 La Terre	Co. tools	Bayou Penchant Terrebonne	8- 9-60 12-22-60	18.6# @ TD	12,662-80	240.8 b/d 44.3° 482 mcf 13/64" TP 6200	FW. No. 68 sd 36'. 118 days to drill. 63 bits.
18,029 15,014	C. Hunt Sands, #C-1 Lacassine	Penrod Drlg. Co.	S. Thornwell Cameron	12-24-60 6-16-60	Gyp base	14,994-15,014	46 b/d 52.6° 1617 mcf TP 6500	FWC. Ext. fld. south. Miogypsinoides sd. 133 days. 62 bits.
18,263 D&A	Union Texas Nat'l Gas #1 U. A. Simone	Gordon Drlg. Co.	Le Leux Vermilion	10- 7-60 5-18-60	18.6# max. to TD			WC. 215 days to drill. 76 bits.
18,400 D&A	Humble St. Lse. 3419 #1	Co. Rig 20	Lake Laurier Lafourche	8-13-59 5-17-60	Gyp-Q-Broxin 13.1# max.			WC. 250 days to drill.
18,600 D&A	Placid Oil, #B-7 LL&E	Penrod Drlg. Co.	Lapeyrouse Terrebonne	10-18-59 2-23-60		PBD 15,450		WC. 122 days to drill. 99 bits.
19,061 P&A	Hunt Oil, Federal OCS-0426 #4	Penrod Drlg. Co.	Blk 77 St. Mary	5- 4-60 10-14-60	Oil base			FW. 156 days to drill. 50 bits. Deepest offshore South La.
20,014 11,850	W. T. Burton #3 P. J. Miller		Sw. Esther Vermilion	4-16-60 10- 4-60		11,838-50	26 b/d 48.7° 2600 mcf 18/64" TP 4000	WC. Fld disc. Siphonia Davisi sd.
20,077 14,720	Placid Oil #3 C. W. Boughman	Penrod Drlg. Co.	Patterson St. Mary	3-13-60 10-22-60		14,700-20	5100 mcf 13/64" TP 4750	FWC. West flank. Discorlies B-2 sd. 163 days. 118 bits.
21,300 12,138	Texas Crude #1 L. Crist 7 Unit 2	J. P. Owen	Esther Vermilion	9- 4-60 10-11-60		12,132-38	13 b/d 46.2° 1560 mcf 7/64" TP 3700 37 b/d 43.3° 2078 mcf 7/64" TP 3950	FWC. Conf. Dual gas (Upper sd.-new pay) #1-D sd. Orig. loc. #1 J. C. Lutring et al.
21,416 D&A	Miss. River Fuel-Calif. Co. #7 LL&E		Bayou Raphael Lafourche	11-16-60 12- 3-60				WC.
			MISSISSIPPI					
15,000 D&A	B. E. Gamble #1 Dr. I. C. Farmer et al		WC Simpson	6- 4-60				WC. Houston test.
15,002 10,453	Humble Oil, Eloise Hicks Thompson	Big Chief Drlg. Co.	Bentonia Yazoo	5-31-60 12-28-60		10,445-53	305 b/d 44.4° 1/4" TP 420	WC. Disc. well. 153 days to drill. Houston sd. 8'.
15,013 13,114	Gulf Oil et al Gwinville Gas Unit #108	Larco Drlg. Co.	Gwinville Jefferson Davis	2-12-60 10-13-60	Fresh water clay-oil emul.	13,114	81 b/d 50° API 3500 mcf Adj. Ch. 4000#	FWC. Ext. field. Mooringsport sd. 25'. 118 days. 111 bits.
15,985 13,235	Pan American #1 Jessie Robertson		WC Jefferson Davis	5-12-60		13,230-35		WC. Gas disc. Paluxy-Mooringsport sd.
			NEW MEXICO					
15,141 11,180	Texaco #1 Remuda Basin	Sharp Drlg. Co.	WC Eddy	5-22-60 12-15-60		11,111-80	72 b/d 47° 28/64" TP 100 CP 450	WC. New disc. Wolfc. sd.
16,506 14,829	Conoco #6 Bell Lake Unit.	King Drlg. Co.	San Simon Sink Blk 115 Lea	10-25-59 6-23-60	Fresh water w/gel to 890', brine water w/filter coke to 5800' oil emul. w/filter coke to TD	14,568-829	36 b/d 53.1° COF 30,500 mcf BHP 6358	WC. New gas disc. Devonian sd. 118'. Drilled in 240 days. 186 bits.
			NORTH DAKOTA					
15,135 11,826	Amerada #1 Antelope unit.	Worley & Harrell	Antelope McKenzie	6-22-59 3-18-60		11,826	230 b/d 36.5° 250 mcf 12/64" TP 900 79 b/d 44.9° 320 mcf 14/64" TP 425	WC. Disc. field. Dual in Duperow and Silurian sd. 172 days. 171 bits. Deepest in N. Dak.
			OKLAHOMA					
15,000 9,472	Pasotex Pet. #1 R. S. Bond	Noble Drlg. Corp.	WC Carter	8-15-60 12- 2-60	Gyp-Q-Broxin	9,423-72	Pumped 77 b/d 38°	WC. Oil disc. 410'. Hunton lime sd. 65 days. 46 bits. Deepened from 12,825'.
15,083 14,615	Mobil #1 J. F. Davis Unit	Co. Rig 38	N. Custer City Custer	12- 9-60		14,615	497 mcf Open ch. SITP 3750	FW. 40 days to drill. Devonian-Hunton sd.
15,201 15,194	Pasotex Galtry #2-1	Falcon Seaboard	S. E. Marietta Love	9-22-59 4-28-60		14,975-15,194	1 b/d 53° 100 mcf 24/64"	FWC. Conf. Ox creek sd. 199 days to drill inc. 34 days of fishing.
15,679 15,679	Pasotex #1 Jack Brannan 3 unit 2	Noble Drlg Corp..	S. E. Marietta Love	7-31-59 3-22-60	Lime base	13,889-15,679	25 b/d 53° 1800 mcf 12/64" TP 2750	WC. Disc. gas fld. Arbuckle limestone sd. 206 drlg. days inc. 45 days fishing and side-trkg.
15,744 D&A	Pasotex Brannan 2-1R	Falcon Seaboard	S. E. Marietta Love	7- 5-60 12- 9-60	Gyp-Q-Broxin			FW. 151 days to drill. 104 bits.
15,860 15,840	British Am. #1-X Vera Hunsy	A & P	Knox Bromide Stephens	9-10-60 11-27-60	Oil base mud.	15,358-840		FW. workover. 2 & 3rd Bromides 351' gross. PB & whipstocked to 15,860, perforated and fractured. Depth record for Fracturing.
16,282 15,810	Sinclair Oil #1 Moody	Big Chief Drlg. Co.	Carter Knox Stephens	1-13-60 1-17-61	Baroid to TD Comp. w/oil base.	15,784-810	76 b/d 57.5° 5780 mcf 16/64" 8711 psig @ 15,727'.	FW. Fld. Ext. 2nd & 3rd Bromide sd. 289 days to drill. 198 bits.

TABLE 7. DESCRIPTION OF WELLS IN THE UNITED STATES DRILLED 15,000 FT AND BELOW — (continued)

1. TD, ft 2. Prod. depth(s)	Company well	Drilled by	1. Field or area 2. County/parish	1. Spudded 2. Completed	Mud program	Perfs. ft.	Initial prod/d, gravity, coke, tubing pressure.	Remarks
			OKLAHOMA — (Continued)					
17,566 D&A	Texaco Cruse #1	Helmerich & Payne	Knox Stephens	1960				FWC.
17,598 TA	Panotex #1 R. F. Brannan Unit #4	Nichols Drlg. Co.	S. E. Marietta Love	12-12-59 12-21-60	Gyp-Q-Broxin			FW. 374 days to drill inc. 149 days for fishing & sidetrkg. 281 bits.
19,695 D&A	K. A. Ellison #1 Anadarko Basin	Parker Drlg. Co.	WC Caddo	12-15-59 7-15-60	Water base gel.			WC. Derrick broke in two. 36 bits inc. 4 diamond corebeads and 14 diamond bits.
			TEXAS					
15,000 D&A	Texam Oil #1 Hayes Exzell	Parker Drlg. Co.	WC McMullen	1960				WC.
15,005 7,650	Pure Oil #1 Adelia Cessena	Clegg & Hunt	Hardin Liberty	11- 1-59 1-16-60	Gyp-Q-Broxin, oil emul.	48/7, 634-8, 7,642-50	24.84 b/d 36°	WC. Disc. fld. in Oliver sd. 77 days. 37 bits. Drilled by Woodley.
15,920 D&A	Pan American #1 Stewart Title Guaranty		Highland Bayou Galveston	6-29-59 1-23-60				WC.
15,068 D&A	Pan American #5 R. B. Peters		Gillock Area Galveston	11-26-59 3-29-60				WC.
15,214 11,923	Shell Oil #1 A. A. McAllen	Penrod Drlg. Co.	McAllen Ranch Hidalgo	3-16-60 6- 7-60	Calcium surfactant	11,916-23	Shut-in	WC. Disc. gas in Vicksburg sd. 105 days. 61 bits.
15,240 D&A	Humble, J. H. Hazel #1	Maxwell Herring	Edgewood Northeast	6-28-60 12-31-60	Gyp-Q-Broxin oil emul. 11.4# max.			WC. 189 days to drill.
15,300 15,147	Mobil Oil #1 Kath. I. Moore		WC Pecos	1-14-59 2-21-60		15,041-147	15B/mmcf 105mmcf/d Abs. open flow. BH SIP 12,590	WC. New gas disc. Pennsylvanian sd. 387 days to drill inc. blowout & redrill.
15,333 D&A	Gulf Oil, Robbin A #11-E	Helmerich & Payne	Puckett Pecos	6- 7-59 1- 1-60	Gas drlg. & salt water mud.			FW. 202 days to drill. 118 bits.
15,373 TA	Pure Oil #1-A Wm. M. Forrest	Meadows & Walker	Ft. Trinidad Madison	8-27-60 1- 5-60	Gyp Spersene oil emul.			WC. 115 days to drill. 95 bits.
15,445 D&A	Phillips Pet. #1-A McKenzie	Co. tools	WC Pecos	6- 8-59 1-27-60	Low solids Driscose			WC. 129 days to drill. 92 bits.
15,457 D&A	Shell #1 Hebert Broussard "B"	Dillard & Waltermire	Hebert Ranch Jefferson	5-22-60 7-11-60	Gyp-Q-Broxin oil emul.			WC. 44 days to drill. 16 bits.
15,491 D&A	Flaitz & Mitchell #1 W.B. Ferguson, Jr.	Meadows & Walker	WC Matagorda	6-23-60 9-17-60				WC.
15,708 D&A	Mobil Oil #1 J. M. Corder	Co. tools	WC Terrell	10-25-59 7- 7-60				WC. 268 days to drill.
15,766 D&A	Mobil Oil #1 Ivy B. Weatherby		WC Pecos	1960				WC.
15,958 D&A	Grande Corp. #1 Harriet Alexander	Co. tools	WC Grayson	7-10-59 10- 8-60				WC. Orig. hole drilled to 16,363. Sidetkd.
16,000 11,733	Pan Am. #1 Silver Lake Ranches	Stewart & Gouger	Silver Lake Matagorda	6-20-60 8-22-60		11,717-33	9 b/mmcf/d. abs. open flow. 52.1° SITP 8065, BHSIP 9840	FW. New gas. disc.
16,005 D&A	Tidewater #1 Holman Cartwright	Bilbo-Redding	WC Live Oak	8-13-59 1- 9-60				WC.
16,009 13,646	Shell Oil #1 Eli Rich	Dillard Waltermire	So. Raywood Liberty	8-12-60 12- 7-60	Low pH Q-Broxin	13,634-46	41 B/mmcf 52.1° 25,000 mcf BHSIP 12,200	FWC. Disc. Yegua gas sd. 79 days to drill. 38 bits.
16,067 D&A	Midwest #1 Houston Farms Dev.	Meadows & Walker	WC Brazoria	3-26-60 6-18-60	Gyp base oil emul.			WC. 69 days to drill. 33 bits.
16,091 D&A	Shell #1 Fed. Blk. 288, OCS TR 0709	Zapata Offshore	Federal area Galveston	8-24-60 11- 8-60	Gyp-Q-Broxin oil emul.			WC. Offshore. 76 days to drill. 39 bits.
16,546 D&A	Gulf Oil, Oliva E. Phillips et al #1	Steen Drlg. Co.	SW Hawkinsville Matagorda	1-30-60 11-28-60	Phosphate to 6000'; Gyp-Q-Broxin to TD.			WC. 97 days to drill. 38 bits.
16,937 10,554	Monsanto Chemical #1 Buckeye	Mac Drlg. Co.	Wilson Creek Matagorda	4-12-60 8- 4-60	Milwhite Gyp-Q-Broxin	10,545-54	330 b/d 46.7° 5,650 mcf 1/4" FTP 4815; SITP 6150	WC. Disc. Basal Frio sd. 10'. 85 days. 44 bits. Abs. open flow 21,000 mcf/D.
18,008 D&A	Grande Corp. #1 T.W. Harshbarger	Co. tools	WC Grayson	6-14-59 8-27-60				WC. 434 days to drill. Deepest in Texas Panhandle.
19,696 16,820	Atlantic Ref. J. C. Kelly #1	Great Western	Hershenson Pecos	8- 4-59 7- 8-60	FW Cypan (Magcobar) 10.6#	16,820	No official test.	WC. Disc. new field. Devonian, Silarier Ellenburger sd. 245 days. 190 bits. Shut-in waiting on special tubing.
19,765 11,203	Shell Oil #1 Wm. M. Carroll	Meadows & Walker	Brushy Creek Dewitt	5-23-60 3- 8-60	Calcium surfactant	11,187-203	10 B/mmcf 44.4° 13,000 mcf	WC. New gas disc. 245 days to drill. 92 bits.
20,603 D&A	Hunt Oil J. O. Walker #1	Penrod	WC Webb	1960				WC. Deepest in SW Texas.
			WYOMING					
16,500 D&A	Pure Oil #2 Unit A		Badwater Natrona	6-10-60				FW.

Chemical Treatment For Well Stimulation

Use of acids and surfactants, alone or with other stimulation techniques, can solve many production problems

FRANCIS N. HARRIS, *Halliburton Company, Duncan, Oklahoma*

CHEMICAL TREATMENT for well stimulation has come to the forefront in recent years. Although the first oil well was acidized before the turn of the century, acidizing has had a rather short history of approximately 30 years in the industry's first 100 years of progress. The use of surface active agents or surfactants has enjoyed a much shorter existence.

ACIDIZING — PAST AND PRESENT

Years ago "raw" hydrochloric acid was dumped and gravity flowed into formations. Later small pumps with inadequate horsepower slowly displaced the acid. A common occurrence was the inability to break down tight formations with acid even though the zone was highly acid soluble.

Many other obstacles were encountered. No attempt was ever made to maintain compatibility between the treating acid and the well fluids nor isolate and treat only the productive zones. As a result, the success-failure ratio was often times discouraging.

Today, hydrochloric acid is still basically the main constituent in acidizing, because it is the most efficient and economical acid available for permeability improvement. However, acids are modified to fit the well conditions in advance of anticipated difficulty. Modified acids include: Nonemulsifying, retarded, mud cleanout, thickened, and other formulated acids for specific well problems.

SURFACTANTS — PAST AND PRESENT

Surfactants (a coined word taken from surface active agents) were first used in acidizing some 20 years ago. All the above mentioned modified acids contain surfactants. The real progress in the wise use of this group of compounds has been made in the last 10 to 15 years. Intensified research by service companies and oil companies has made this possible.

A more thorough understanding of surface active chemistry as applied to well stimulation has been responsible for the growth of this type of treatment. Problems in which water blocks and oil-water emulsions are restricting production are the best examples where application of surface active chemistry enters into the design of a treating solution.

Surfactants, even in very low concentrations, have the unique property of changing the surface characteristics between various states of matter. Surface tension and interfacial tension values are altered measurably by these agents because they have a tendency to concentrate at interfaces. Some of these compounds are soluble or dispersible in aqueous media, others are soluble or dispersible in petroleum base fluids.

WELL TREATMENTS

The end result of any successful chemical treatment is the placement of a sufficient quantity of the correct type of material to a treatable formation. Three general decisions must be reached in the planning of a stimulation treatment: (1) proper mixture, (2) optimum volume from the standpoint of economics and maximum production, (3) method of placement (injection rates, pressures, etc.). Each of these factors has many avenues of approach. However, they are favorably concluded by having a thorough knowledge of the chemical and physical properties of the treating solutions, in addition to an understanding of well problems.

Acidizing—General Information

Successful acidizing in limestone and dolomite formations depends on a productive drainage pattern formed by the action of the acid on formations. This may be accomplished by: (1) creating crevices with hydraulic fracturing and increasing the crevice size by dissolving a portion of the forma-

This article is one of a series of Modern Well Completions based on lectures given by industry authorities before a Petroleum Engineering Seminar course, PE-270, at The University of Texas, Austin.

ABOUT THE AUTHOR

Francis N. Harris is a staff engineer in the Production Improvement Department of Halliburton Company. He joined the company as a senior chemist in 1946 following four years service in the Navy during World War II. He graduated with a BS degree in chemistry from Texas Technological College in 1942. Prior to his promotion to staff engineer, he was a development chemist in the Analytical Section of the company's research and development laboratories in Duncan, Oklahoma.

For any type well completions... your best *connection* is...

HYDRIL TUBING JOINTS

Talk with operators who've had experience with them. An operator who has just brought in a quadruple completion—four independent strings to pay zones between 9,000 and 10,000 feet—using 2⅜" Hydril "CS" Tubing Joints in 9⅝" casing, says. "The Hydril 'CS' Joint is an easy joint to run. With its two-step thread, it makes up fast. It's pressure-tight when made up and you can depend on it to stay that way."

For faster, safer high-pressure or multiple completions, use Hydril Tubing Joints in your wells.

HYDRIL COMPANY

714 West Olympic Boulevard, Los Angeles 15, California
Factories: Los Angeles, Calif.; Houston, Texas; Rochester, Pa.

Sales offices: Bakersfield, Los Angeles, Ventura, California; Harvey, New Iberia, Louisiana; Youngstown, Ohio; Oklahoma City, Tulsa, Oklahoma; Rochester, Pennsylvania; Corpus Christi, Dallas, Houston, Midland, Odessa, Texas; Casper, Wyoming; New York, New York; Calgary, Edmonton, Canada.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

tion with acid as it travels back into the formation; (2) improving the permeability of existing crevices by enlargement and inter-connecting these crevices by chemical action; (3) occasionally, the removal of a "skin effect" caused by drilling mud will be all that is required.

Drainage patterns. The extension of drainage patterns in formations will obviously require deeper penetration in some producing zones than in others, regardless of whether they are naturally existing or artificially made. This distance obviously is dependent upon the quantity of hydrocarbon per unit volume of rock as well as rock pressure.

To realize fully the effect of any acidizing job, an unplugged condition must exist from the face of the well bore to the most extended distance reached by the treatment in the pay section. It is very important that acid insolubles that have been dislodged by the chemical action on the formation be removed after acidizing in addition to maintaining treating acid and well fluid compatibility. The proper surfactant will aid in preventing re-plugging of the crevices as the formation purges the spent fluid carrying insolubles.

Formation characteristics. Limestones and dolomites do not normally have continuous porosity. Treating acids will invade these formations under pressure along non-uniform lines of least resistance, resulting in a very uneven distribution of acid in the producing section. This can be an advantage or it can be very detrimental.

If uniformity exists throughout the producing zone and acid is entering the formation in one crevice, a considerable distance will be penetrated because only one fracture is taking acid. If this crevice remains open for transporting fluid after acidizing, a deep drainage pattern will be present and a successful job will have been accomplished, providing oil can migrate vertically to the crevice.

However, if shale stringers extend from the bore a considerable distance without "pinching out," they will act as barriers to fluids migrating vertically into an acidized crevice that is open to the well bore. If treating acid has invaded the formation above or below these shale beds, only that section taking the treatment will have production improvement.

Occasionally, a thin section between shale breaks will act as a "thief zone" — taking the acid and allowing a major portion of the productive pay to go starving for treatment. Many times, "rotten" shales that have a high horizontal permeability because of distinct bedding planes, but have no vertical permeability, will feed on a major portion of the acid. A zone of this type will be reluctant to give back the acid. When slugs do come back, they will be only partially spent because acid does not react with shales as it does with carbonates.

All of these examples will give disappointing results unless techniques are employed to help alleviate the situation. Ball sealers, temporary plugging agents, gels, and controlled emulsions have been used as diverting agents between stages of acid.

Successful acidizing can be accomplished only if the producing pay can be isolated for treatment. A good casing cement job is a prerequisite. If a cement bond between casing and formation does not exist, acidizing under pressure may cause the acid to migrate vertically behind the pipe and out of its intended zone.

Acidizing will not ruin a good cement job, even though cement has a high acid solubility (Portland cement is approximately 65% acid soluble). That portion which is insoluble will soon form a protective coating of silica gel between live acid and unreacted cement.

Even though importance is always given to reservoir data normally obtained from core analysis, i.e., permeability, porosity, and fluid saturation, these data cannot be relied upon in limestone and dolomite wells as effectively as the same information from homogeneous sand cores.

Lack of uniformity in limestones and dolomites makes correlation most difficult. In many instances, core samples, through an entire pay section, will have less than one millidarcy permeability by analysis, yet the well will flow several hundred barrels of oil per day. The reason for the production capacity increase over the theoretical is the presence of crevices and fractures which, in spite of their very small width, have effective permeabilities much greater than that of the rock itself. The general nature of the flow of fluids in carbonate rock may thus be described as being one in which the main body of the reservoir feeds into highly permeable fractures, the latter transporting the fluid to the well bore. Thus, a uniform network of crevices will give a resulting effect similar to a radially uniform sand body; whereas, if there are only a few but extended fractures, the flow system may assume at least some likeness to a linear channel. Some verification of this reasoning is found in the calculations that follow:

Calculations. Flow of fluids under pressure in a uniform porous media can be easily calculated by a standard simplified formula[1]:

$$V = 0.0257(H)(K)(P)$$

where: V = volume in gal per min
H = height in ft of porous media
K = permeability in darcies
P = pressure in psi

If we take, for example, a 10-ft zone with a permeability of 10 millidarcies or 0.01 darcy and an injection rate of 50 gal per min, we find:

$$50 = 0.0275(10)(0.01)(P)$$

$$\text{or: } P = \frac{50}{0.0275(10)(0.01)}$$

P = 18,200 psi for a pumping rate of slightly over 1 bbl per min.

If we consider a 5000 ft well and using 15% hydrochloric acid, the hydrostatic pressure will be:

psi hydrostatic = (depth in feet) (weight of fluid in lb per gal) (0.052) = (5000) (8.95) (0.052) = 2.327 psi
Therefore, required pump pressure = 18,200 – 2,327 = 15,873 psi to inject 15% acid into the formation.

However, this is highly improbable. Obviously, there is a breakdown in the formation and the acid is injected into enlarged crevices through existing natural fractures or hydraulic fractures. Flow of the fluids has changed from radial flow through matrix permeability to linear flow through crevices. Crevices having 0.00004-in. thickness have a permeability of 83.3 millidarcies. This is over 8 times that shown in the above example. With all other factors being equal, it would require one-eighth the pressure to inject fluid. All calculations are based on viscosities equivalent to water.

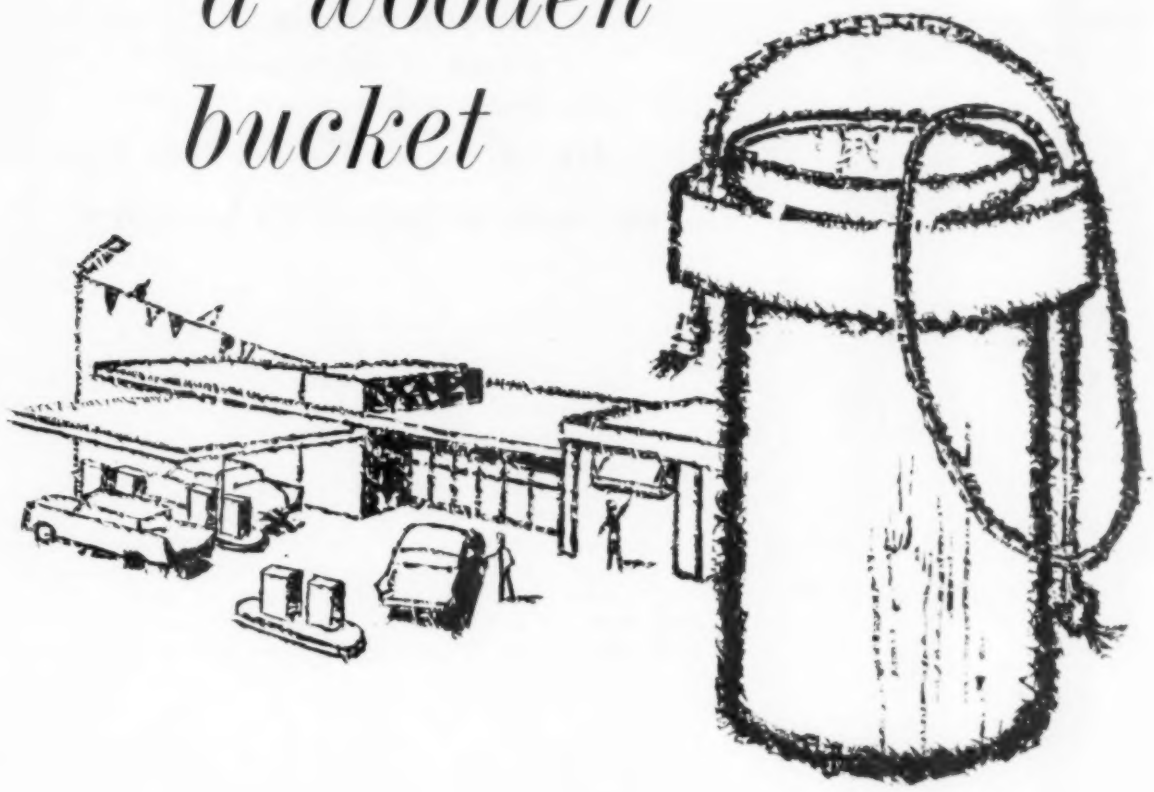
Stage Acidizing

An important factor in any acidizing treatment is the optimum volume of acid to be used from the viewpoints of economics and maximum production. Several points must be considered in making this decision.

If the flow into the well is essentially radial (owing to an approximately uniform distribution of fractures of limited extent) and the pay immediately surrounding the well bore is of normal permeability as compared to the main body of limestone, an increase of permeability in the zone adjacent to the well bore due to the introduction of acid will give a relatively small increase in production capacity of the well. In fact, even if the acid should completely dissolve away the limestone up to a radius of 5 ft, the production capacity of the well will be increased by only 65%.

Number 4 of a Series
TELL THIS PETROLEUM INDUSTRY FACT TO YOUR NEIGHBOR

It started with a wooden bucket



A long the early rutted trails of Pennsylvania rolled the Conestoga wagons with a wooden tar-bucket slung from the rear axle. Teamsters swabbed smoking hubs with a mixture of tar and lard, or with petroleum seepage when they could find it. That tar-bucket is the ancestor of the service stations that today pump 42 billion gallons of motor fuels into passenger cars and trucks each year.

This necessity is taxed more than most luxuries; Federal and state taxes add nearly 50% to the price of gasoline. The petroleum industry has developed better fuels at lower actual cost, but taxes have eliminated any benefit to the consumer. Since 1925, *taxes* on gasoline have increased 380%. The average price of gasoline (not including taxes) has increased *only 1%* during the same period. No other industry has made so many product improvements with so small an increase in actual cost during this period of declining dollar purchasing power.

© COPYRIGHT 1961 BAROID DIVISION NATIONAL LEAD COMPANY

BAROID

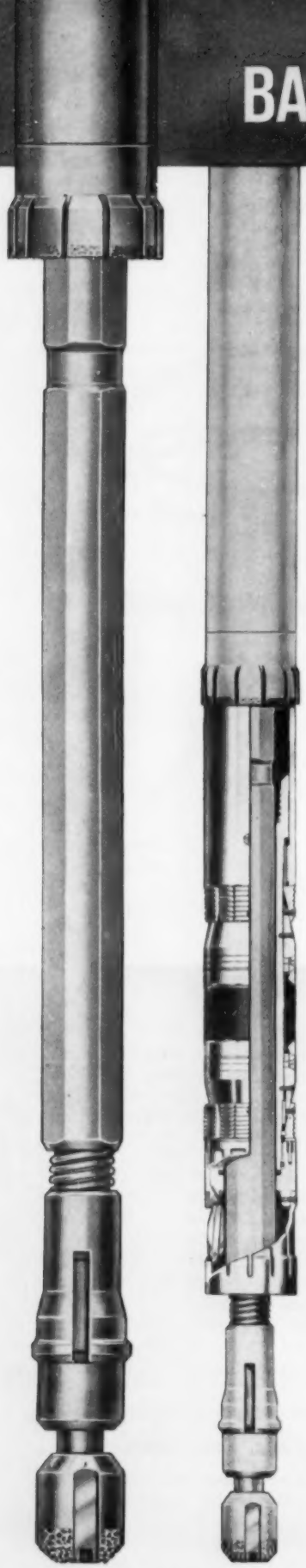
BAROID DIVISION NATIONAL LEAD COMPANY
MAIN OFFICE: P. O. BOX 1675, HOUSTON 1, TEXAS

BAROID—*Still Pioneering Drilling Mud Research • Engineering • Marketing*

Reproduction proofs of this message are available with or without the Baroid Signature . . . Write Advertising Manager, Baroid Division.

6103

BAKER PACKER MILLING TOOLS



Product No. 747-C

Now! Mill Over

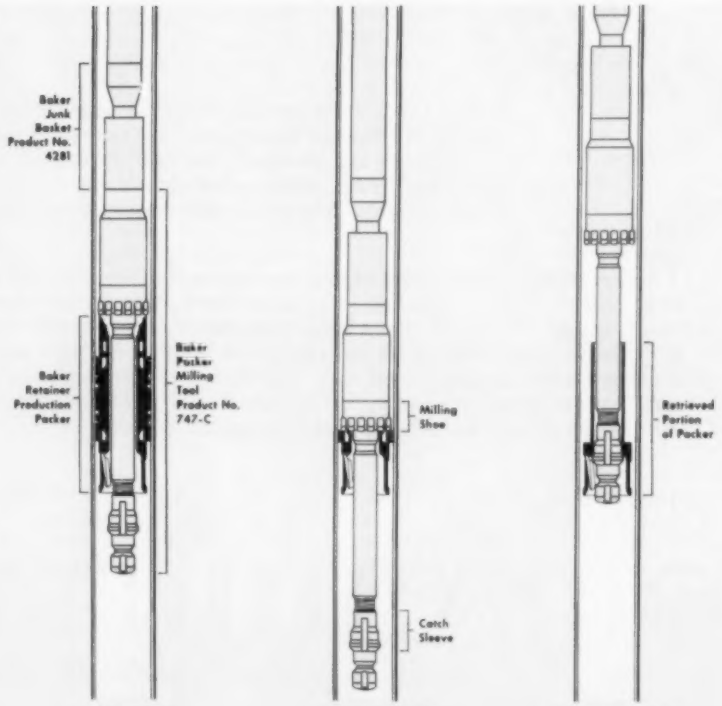
DRILLABLE PACKERS,
BRIDGE PLUGS,
CEMENT RETAINERS

in 75% less time

...retrieve or push to bottom

To reduce the time required to drill-out packers with rock bits, Baker introduced, in 1959, its Packer Milling Tool for use with Baker Retainer Production Packers. Utilizing its specialized engineering skills, derived from designing and building more drillable packers and bridge plugs than any other manufacturer, Baker tailored this tool to do this specific job with maximum efficiency. So successful was the new tool that packer mill-out times averaged one-fourth the time that was formerly required.

To meet the needs of the industry for an equally efficient means of milling out other drillable packers, Baker has expanded the number and variety of Packer Milling Tool models and sizes. Baker can now mill-out and retrieve *any* retainer-type packer or Baker Bridge Plug, in addition to Baker Retainer Production


Baker Junk Basket Product No. 4281
Baker Retainer Production Packer
Baker Packer Milling Tool Product No. 747-C
Milling Shoe
Catch Sleeve
Retrieved Portion of Packer

1 ENGAGING PACKER
2 MILLING OVER PACKER
3 RETRIEVING PACKER BODY

Packers. Where retrieving is not required, other models are available for milling out and pushing to bottom *any* bridge plug or cement retainer, as well as the packers and plugs previously mentioned... one or two at a time, if required.

With the Baker Packer Milling Tool you save a great deal more than just time. For experience has shown (see case histories at right, for example) that lightweight workover rigs generally can be used satisfactorily. The use of tubing instead of drill pipe and collars often adds further savings. And report after report states that the job was accomplished without circulation, using only a minimum amount of fluid, spotted as needed.

But speed and savings are not the entire story. It may be of great importance to successfully retrieve the packer or plug from the well. Such is the case where it is necessary to remove the upper packer in a multiple completion without damaging the lower packers. Or where the packer or plug is set above a smaller O.D. liner.

Drawing on their long experience in designing ways to latch into and hold onto packers, Baker built the dependable catch sleeve (with safety release) which is used to hold the packer body for retrieving. Again, field experience has proven this feature to be both practical and reliable.

To benefit most from the high degree of drillability that is built into Baker Retainer Production Packers, Bridge Plugs and Cement Retainers... ask your Baker man to provide you with milling tool service. He is well-prepared to help you with your special problems.

BAKER
OIL TOOLS, INC.
HOUSTON,
LOS ANGELES,
NEW YORK

BAKER

A BAKER JUNK BASKET installed immediately above a Baker Packer Milling Tool will remove most of the metal cuttings ... enabling the milling tool to do a more efficient job.

Reminder:

Removing cement sheath, perforation burrs and other obstructions will reduce the number of prematurely set and leaking packers and plugs... reduce the need for milling jobs. Clean your casing with a

BAKER ROTO-VERT CASING SCRAPER

LOOK AT THESE RESULTS

Kansas

MILLED OVER AND RETRIEVED BAKER RETAINER PRODUCTION PACKER

MILLING TIME: 45 MINUTES

Packer Size 5½", 5,000 ft. No circulation, let 50 bbls oil gravitate down casing.

Oklahoma

MILLED OVER AND RETRIEVED BAKER RETAINER PRODUCTION PACKER

MILLING TIME: 1 HOUR, 15 MINUTES

Packer Size 7", 19,435 ft. Circulation: 3½ bbls/min.

New Mexico

MILLED OVER AND RETRIEVED RETAINER-TYPE PACKER

MILLING TIME: 2 HOURS, 30 MINUTES

5½" Brand "X" Packer, 7500 ft. Fluid 2500 ft. down. Junk Basket really paid off.

?

Wyoming

MILLED OVER AND PUSHED TO BOTTOM BAKER MAG. BRIDGE PLUG

MILLING TIME: 35 MINUTES

Bridge Plug Size 5½", 6,700 ft. Used pulling unit, rotating head and pump.

Texas

MILLED OVER AND RETRIEVED BAKER RETAINER PRODUCTION PACKER

MILLING TIME: 1 HOUR, 15 MINUTES

Packer Size 5½", 7,000 ft. Used 5,000 lbs. set-down weight. 60 rpm Used Junk Basket.

Louisiana

MILLED OVER AND RETRIEVED BAKER RETAINER PRODUCTION PACKER

MILLING TIME: 2 HOURS

Packer Size 7", 6400 ft. 1½ hours to retrieve.

However, if the well is plugged or if the limestone surrounding the well bore is of an abnormally low permeability, introduction of acid should be considerably more effective in increasing the production capacity of the well.[2] For example, if the zone about the well bore has a permeability one-tenth that of the main body of the limestone and is raised to that of the latter by the acid, the production capacity of the well will be increased by 70% even if the affected zone is only 3 in. thick, and by as much as 350% if the acid penetrates to a radius of 5 ft.

Formation damage. New wells will inevitably have some permeability damage near the well bore. A "mudded off" condition, or "skin effect," always exists to some extent in newly completed wells. In doing the job for which it was designed, drilling mud will form an impermeable cake on the well bore and will fill some of the formation voids near the bore.

Depth of penetration of this damage is dependent on 3 general factors: (1) Characteristics of formations are such that they will take some solids while maintaining circulating pressures (an extreme example is a lost circulation zone); (2) Hydraulic surges of running pipe and pipe whipping against the side of the bore hole will shove mud solids into the formation; (3) Drilling properties of the mud become altered and invasion results before corrections can be made. While the extent of mud invasion is difficult to determine, it can be definitely stated that the greatest degree of damage is that nearest the bore facing.

An acid solution is the most effective material for helping to remove this barrier. Neither a large quantity nor a high concentration of acid is normally required for this first stage of mud clean out treatment. Naturally, the governing requirements on volume and concentration are: (1) To what extent has the permeability damage penetrated the formation?; (2) What is the acid solubility of the invaded mud and the solubility of the formation?

Penetration is frequently limited to the immediate vicinity of the bore unless lost circulation was encountered. If so, one-half barrel of treating acid per foot of formation will ordinarily suffice. In calcareous formations 15% acid concentrations would be most effective. Presence of high acid soluble solids dictates this reasoning. Acid concentrations can be lowered to 5% for formations containing no carbonates, providing the mud solids also contain no appreciable amount of acid solubility.

Second stage. If a decision is reached by the well operator that the first stage treatment gave encouraging results, but not in sufficient quantities to be considered near the potential, a second stage of acid is normally run. Design of this type of solution can be different from the first stage. In this instance, fracturing with crevice enlargement and/or crevice extension and crevice connecting is desired, as previously mentioned.

Common Types of Acids

Mud Cleanout Acids

Mud cleanout acids or first stage completion acids are of two general types: (1) from 5% to 15% hydrochloric acid containing 3% surfactants by volume; (2) mixed acids containing from 8 to 12% hydrochloric and 3% hydrofluoric. These two types are formulated primarily to assist in the removal of permeability damage which may be caused during drilling operations. However, they are used frequently for other problems. They are different in formulation to help remedy different existing well conditions.

The first acid has an extremely high surfactant content that aids in the restoration of normal permeability without additional chemical reactions which, under certain conditions, might affect the efficiency of mud removal.

Hydrochloric acid is used in this mixture to effect a shrinkage of the bentonite in the mud. This is done through a base exchange, where the highly swollen hydrated bentonite is converted to the less swollen acid bentonite. The surfactant is added to hydrochloric acid to disperse mud particles, to increase the penetrating properties of the acid by giving it a low surface tension, and to help prevent the formation of viscous oil-water emulsions.[3]

Chemical reaction between hydrochloric acid and hydrated sodium bentonite will result in a considerable reduction in particle size according to the general equation:

$$H^+Cl^- + Na^+\,Bentonite^- \rightarrow H^+\,Bentonite^- + Na^+Cl^-$$

This reduction in particle size is based on high yield bentonite. In the equation, bentonite clay will become flocculated without the surfactant. Because of the adsorbing characteristics of the bentonite, a large amount of surfactant is used to aid in maintaining a dispersion for easier removal.

The second acid (HCl – HF mixture), will also shrink bentonite mud particles in addition to dissolving some of the silicate particles. However, on occasions, chemical side reactions may result overshadowing any expected rewarding results. The chemical reaction of hydrofluoric acid with a low molecular weight calcium salt is considerably faster than with a high molecular weight silicate particle:

$$2HF + CaCO_3 \rightarrow CaF_2 + CO_2 + H_2O$$

The equation shows the reaction of hydrofluoric acid with a calcium salt (limestone) forming insoluble calcium fluoride, carbon dioxide, and water.

HCl – HF acid mixture is an efficient treating solution that aids in the removal of a mud barrier in the absence of fluoride-robbing calcium, provided it is not allowed to "soak" in a formation until additional chemical reactions can take place. For example, hydrofluoric acid will dissolve silica and silicates to form silicon tetrafluoride and water. This is the extent of reaction that is desired to realize fully the effectiveness of this mixed acid.

However, time, temperature, and pressure may cause additional reactions. These are: (1) Silicon tetrafluoride, the gas that is formed, will hydrolize to fluorosilicic acid and silicon dioxide; (2) fluorosilicic acid in turn will react with metallic ions present (soduim, calcium, magnesium, and others) to form the insoluble, or partially insoluble salt of fluorosilicic acid. This series of reactions is represented by the following chemical equations:

$$4HF + SiO_2 \rightarrow SiF_4 + 2H_2O$$
$$3SiF_4 + 2H_2O \rightarrow 2H_2SiF_6 + SiO_2 \text{ (insoluble)}$$
$$H_2SiF_6 + 2NaCl \rightarrow 2HCl + Na_2SiF_6 \text{ (insoluble)}$$

In field operations it is wise for the well owner to swab this spent acid mixture back as soon as possible for best results.

Non-Emulsifying Acid

Non-emulsifying acid is regularly used in limestone and dolomite wells as the stage of acid most frequently used for stimulation treatment. It is an economical solution of hydrochloric acid, generally 15% acid in strength, containing a surfactant to minimize emulsification of acid and crude or spent acid and crude. The surfactant also acts as a sediment dispersant.

Since this acid is often used in larger quantities than the first stage mud cleanout acid, only 0.5% surfactant is added to the acid unless specifically requested or needed to help prevent emulsification. The surfactant aids in the removal of acid insolubles dislodged by the acid.

High Viscosity Acids

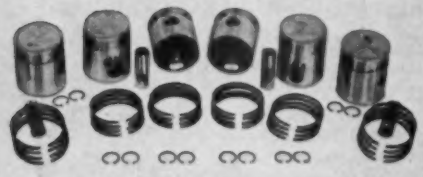
High viscosity acids when properly employed contribute measurably to increased oil and gas production. There are two general types of high viscosity acids available: (1) controlled acid-in-oil emulsions; (2) true acid gels. Both of these exhibit a retarded reaction on calcareous formations, thus allowing

PROTECT YOUR POWER INVESTMENT...

BUY *genuine* WAUKESHA PARTS

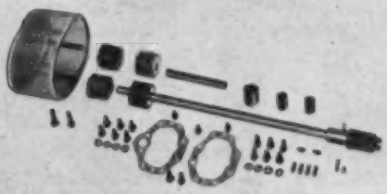
... in the original sealed packages—always obtainable from your Authorized Waukesha Distributor—are your best insurance of continuous satisfaction and economical engine performance.

PISTONS, PINS, RINGS



Matched in sets for weight and balance. Correctly fitted sizes.

OIL PUMP PARTS



Precision bushings, shaft, gears, clearances. Correct gasket sizes.

MAIN AND ROD BEARINGS

Absolutely clean. Numbers correct. Best materials. Perfectly sized.

VALVE LIFTERS

Factory heat-treated and ground. Accurate metallurgy and dimensions.

WATER PUMP PARTS

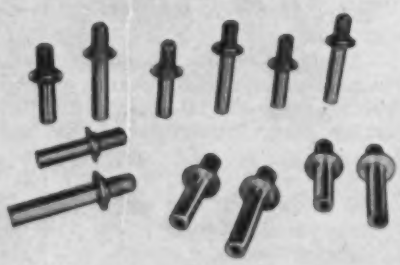
Precision bushings, shaft, seals—accurately balanced impellers.

> **"There is hardly anything in the world that someone cannot make a little worse and sell a little cheaper—and the people who consider price alone are this man's lawful prey."**
>
> *—John Ruskin*

INTAKE AND EXHAUST VALVES

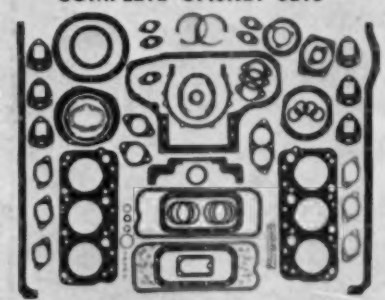
Quality and best materials ensured—no nicks, burrs, hand prints.

VALVE GUIDES



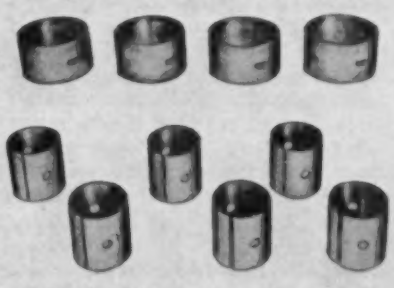
Service sized; inside and out—give just-right valve lubrication.

COMPLETE GASKET SETS



A right gasket for every place on your engine—dimensionally stable.

CAMSHAFT AND PIN BUSHINGS



Pre-sized for service use—no distortion—precise oil metering.

For that extra quick service call your Waukesha Distributor — see alphabetical section, or Yellow Pages in your phone book—you'll have your repair parts in a hurry!

WAUKESHA MOTOR COMPANY, WAUKESHA, WISCONSIN / New York • Tulsa • Huntington Park, Calif.
Factories at Waukesha, Wisconsin and Clinton, Iowa

513

penetration of unreacted acid a greater distance from the bore hole. Both have low fluid loss characteristics which enhance this lateral penetration of live acid.

The controlled emulsion type has from 10 to 25% oil external phase and from 75 to 90% acid internal phase, on a volume basis. Viscosity of the emulsion can be controlled by the degree of agitation and the extent of the oil phase. The emulsion stabilizer used can have its degree of sensitivity (remaining stable or becoming unstable) corrected for the operating well conditions of time, temperature and type of formation. The true gel's viscosity is determined by the quantity of gelling agent present. The thinning in viscosity is also controlled for the operating well conditions.

These acids are frequently used as a diverting treatment between stages of acid. If extremely open zones are encountered during a stimulation treatment, temporary bridging agents are suspended in the high viscosity acid. This technique is especially useful in open hole work for temporarily plugging thief zones.

Penetration Acid

Penetrating acid or low surface tension acid contains nonionic surfactant in the ratios of from 0.1 to 0.3% by volume of the treating acid. With the addition of this surface active agent to hydrochloric acid, the surface tension of the acid is reduced to less than one-half of what it was originally. This reduction in surface tension is lowered to the value of crude oil ranges and results in a better wetting and spreading ability on an oily surface. Also, the low surface tension property facilitates its blending with interstitial water, which aids in a more efficient removal of this water.

Another application of this acid solution is in low pressure formations where prolonged clean-up time is required because of the Jamin effect. Even though the concentration of surfactants is low, which is reflected in an economically priced material, it functions adequately for its intended purpose. Dilution of spent, penetrating acid with formation brine several times does not raise the surface tension of the mixture appreciably.

Iron Retention Acid

Iron retention acid is a solution designed to minimize the undesirable effect encountered by the re-precipitation of iron hydrates. Occasionally, excessive amounts of iron salts are dissolved by acid. These will revert to insolubles when the acid becomes spent. The resulting condition is a redeposition of solids in the flow channels which, when packed by the movement of fluid, will have a plugging tendency.

The most frequent use of iron retention acid is in brine well acidizing. However, this type of acid has an application in oil and gas well acidizing for production improvement. If a producing well that is to be acidized has a thick coating of iron salts and/or iron oxides on the pipe through which the well is to be treated, iron retention acid can be employed to an advantage. It should be emphasized that acid will dissolve these iron compounds regardless of the presence of an inhibitor of any type used for pipe protection.

This iron-bearing acid on becoming spent in the formation exposes the flow channels to a plugging action of re-precipitated iron hydroxide. The distance of penetration that unconditioned acid will invade before this gelatinous precipitate forms is a function of the time required for the acid to spend from the moment it enters the formation.

Acid Ahead of Fracturing

The use of an acid solution ahead of hydraulic fracturing could be considered a chemical treatment aid to well stimulation. This application for acid has become a useful tool to assist in breaking down a formation prior to a fracturing treatment. It has become popular in most all domestic operating areas, at least to some extent. The acids most commonly used in this respect are the mud removal types. In actual practice, the treatment is applied in two ways and performs two functions:

(1) It is used to aid in mud removal around the immediate vicinity of the bore hole. In this instance, the acid is slowly injected into the formation or injected in stages with pauses of from 5 to 15 minutes until the entire volume is displaced into the formation. The spent, or partially spent, fluid is not over-displaced and is swabbed back immediately. This will help clean from the formation a great part of mud solids blocking the normal permeability.

(2) It is used strictly as a "spearhead" to the fracturing fluid. In this instance, the acid is used to assist in initiating the fracture. This is often reflected in a lower formation breakdown than normally encountered with other fluids. There is no intent to swab back, at least not until the fracturing job is completed. It performs its purpose by aiding in higher injection rates and/or lower injection pressures.

In each of the above instances, the effectiveness of the acid solution has helped improve fracturing operations in both sand and calcareous formations. It has been a controversial subject among well owners as to which of these treatments merit the most consideration. Presently, there is an increasing tendency to divide the acid volume and perform both operations. This will add very little cost to the treatment, providing of course, it is the operator's intention to swab back anyway.

Acid as a Perforating Fluid

The use of acid as a perforating fluid is another chemical treatment aid to well stimulation. This application for acid is not as widely used as it is in conjunction with fracturing; however, the usage is increasing. The types of acid most commonly employed are the mud removal solutions.

When reviewing the possibilities that might occur in a zone immediately after perforating, it becomes apparent that an acid solution can aid in restoring normal permeability. The conditions most likely to be present are: (1) cement fines and drilling mud solids driven into the pore space adjacent to the perforation by the discharge, and (2) mud filtrate hydrating the natural clay sedimentation in the formation which adversely affects the permeability by swelling. If these are the obstructions to the normal permeability, acid will partially dissolve the cement fines. Acid will reduce in size, and/or partially dissolve the clays, both natural and foreign to the formation. Entrance of acid into perforations will take place as the charge enters the formation.

FUTURE TRENDS IN WELL TREATMENT

In the future, as dictated by present trends, the use of chemicals in production improvement will continue to grow rapidly. This is understandable because of the intensified research programs that are presently under way within the industry. New products for new and old problems will be developed as a result of this effort.

In most instances, chemical treatments, where applicable, will add only a small percentage to the total cost of drilling and putting a well on production. The use of chemicals is also an economical approach for workover operations.

With these points in mind, obviously chemical treatments have a bright future in the industry.

References

1. Clason, C. E., "Acid Kinetics in Limestone Formations," *The Petroleum Engineer*, March 1955.

2. Muskat, M., "The Flow of Homogeneous Fluids Through Porous Media," First Edition, McGraw-Hill Book Co., Inc., New York, 1937, P. 450-1.

3. Hower, W. F., and Stegelman, Jr., A., "Increased Primary Oil Production by the Wise Use of Surface Active Agents," API Paper No. 826-27-A, April 25-27, 1956.

★ ★ ★

WHAT.. DOCTOR A SUCKER ROD?

Since doctoring won't heal nicks, scratches or bends in sucker rods, Continental rods get *kid-glove treatment* from start to store stocks to prevent surface damage.

Exclusive shot-cleaning blasts away harmful surface mill scale *before forging* to eliminate galvanic cells .. weak spots for corrosion.

Special handling equipment protects the rod's surface during processing.

Palletizing, immediately after painting, prevents nicking and bending rods during storage or truck delivery.

Unique "floating load" cushions rods during rail shipment, so even their protective paint is seldom marred.

Rod Store Stocks are properly racked on special steel supports, faced with wood, to further protect the rods.

Periodical Spraying of store stocks keeps rods in top condition .. ready to be picked up unblemished for longer pumping in your toughest wells.

Six Continental rod grades cover a wide range of prices and metals, enabling you to pump any well at the lowest possible rod cost.

Do the rods you buy get this *extra* care that means longer pumping for lower production cost?

CONTINENTAL-EMSCO

Serving the Oil and Gas Industries .. Worldwide

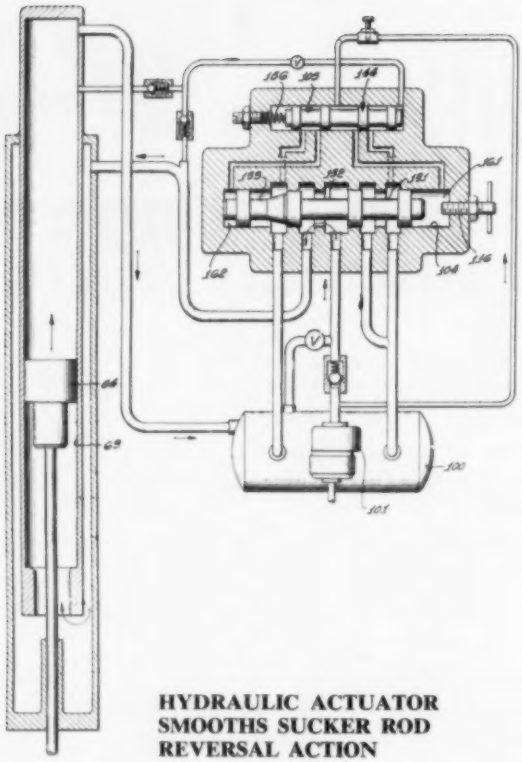
CONTINENTAL-EMSCO COMPANY, a Division of The Youngstown Sheet and Tube Company. General Offices: Dallas, Texas; Export Division: 30 Rockefeller Plaza, New York, N. Y. • Continental-Emsco Company Limited, General Offices: Calgary, Alberta, Canada Continental-Emsco Company C. A., Caracas, Venezuela • Plants: Houston and Garland, Texas; St. Albans, Herts, England • Representatives in All Principal Oil Fields of the World

SR102

WHAT'S NEW IN PATENTS

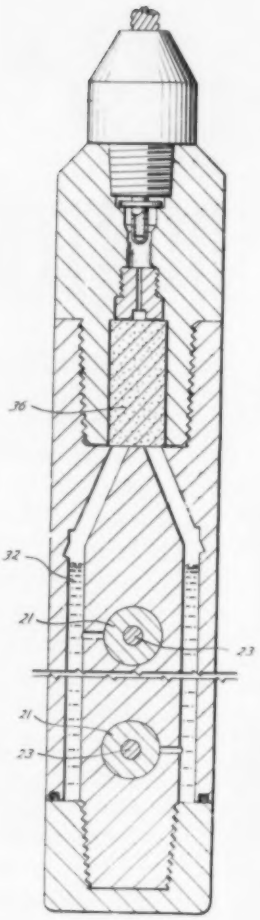
Brief notes on selected oil field patents recently granted

PAUL H. JOHNSON • JAMES R. HEAD, *Patent Attorneys, Tulsa, Oklahoma*



HYDRAULIC ACTUATOR SMOOTHS SUCKER ROD REVERSAL ACTION

THIS PATENT covers a hydraulic type sucker rod actuator for deep well pumps. Novelty of the invention lies in the hydraulic control mechanism. Hydraulic pressure is provided from tank 100. A pilot plunger 144 controls a main valve plunger 132 which in turn controls passage of fluid into and out of the cylinder 63. Pilot plunger 144 is actuated by fluid pressures to control automatically the reciprocation of piston 64 up and down and to control the fluid passages in such a way as to provide for gradual reversal of stroke direction at both ends of the stroke. **Deep Well Pump Reciprocator,** H. M. Salentine, Patent No. 2,950,685.



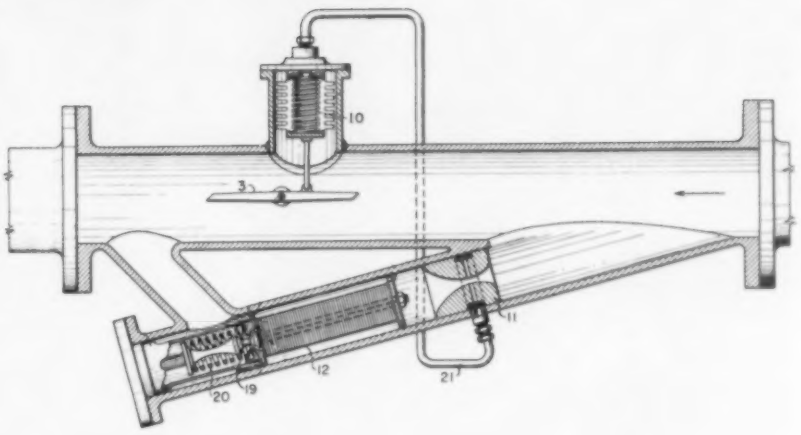
PERFORATING GUN HAS HYDRAULIC BOOSTER

DESIGN OF this perforating gun incorporates hydraulic forces to give an added boost to perforating bullets. Explosion from the main firing charge 36 is transmitted through passageways 32 to a body of hydraulic fluid which is in connection with the individual charges 21. The impact or compressive forces set off the latter propellant charges to drive bullets 23 from the gun barrels. The hydraulic pressure fluid assists the propelling force applied to the bullets. **Perforating Gun,** McCullough Tool Company, Patent No. 2,960,-008.

Want a copy of these patents to study the details? Write to the Commissioner of Patents, United States Patent Office, Washington, D. C. Price is 25 cents for each copy.

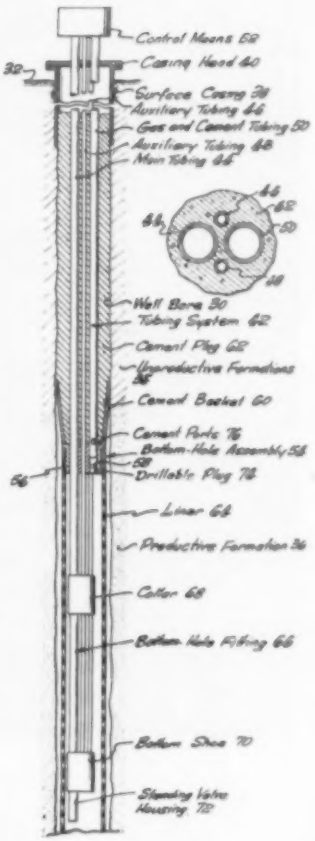
DEVICE DETECTS WATER, CLOSES FLOW LINE

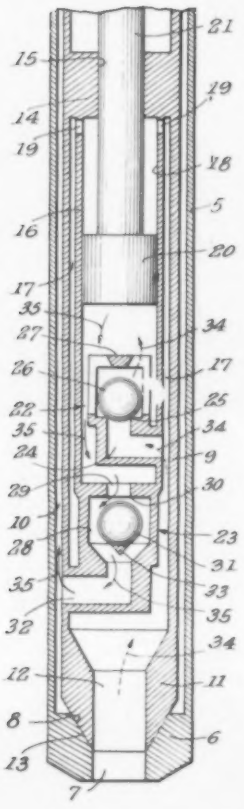
THIS DEVICE is used to close a flow line, such as a line used to convey oil from one tank to another, when water is encountered in the line. Before oil first flows through the device, spring 10 acts to close valve 3 so that all original flow takes place through venturi 11 past valve 19. The effect of the venturi 11 is conveyed through pipe 21 to overcome the force of spring 10, thereby opening valve 3 and permitting fluid to pass. When water is encountered, a small quantity of the water flowing through venturi 11 engages a water-absorptive filter pack 12 which, upon absorbing water, expands. This expansion serves to overcome the force of spring 20 and closes valve 19, preventing fluid from flowing through venturi 11. The force of spring 10 then causes flapper 3 to close. The valve will remain closed until water-soaked filter pack 12 is replaced. The effect of the device is to immediately close an oil line when water is encountered in the line. **Pipe Line Flow Meter,** E. F. Winter and J. A. Wooldridge, Patent No. 2,960,103.



MULTIPLE COMPLETION ELIMINATES LONG CASING STRING

A TYPICAL OIL WELL is completed and produced without a main casing and utilizes only a surface casing to protect fresh water supplies from contamination and perhaps a liner opposite the productive zone to prevent caving of the well. The elimination of conventional casing permits the drilling of a smaller diameter well. At least two tubing strings in side-by-side relation are placed within the well and encased with cement. One tubing string includes a cementing basket and a discharge port through which the cement is discharged into the space between the well bore and tubing strings. This tubing is subsequently used to produce gas from the productive zone. **Casingless, Multiple-Tubing Well Completing and Producing System,** C. J. Coberly, Patent No. 2,939,533.





DOWNHOLE PUMP SAVES SPACE

IN THIS PUMP, fluid is drawn through chamber 7 on upward movement of plunger 20 past valve 25 and into chamber 34. On the downward stroke of plunger 20, fluid is forced through chamber 22 past valve 31 and into annular chamber 10. Annular chamber 10 connects to the surface and is the chamber by which fluid is conducted to the surface. By this novel arrangement the intake and outlet valves are positioned in relative proximity to each other. The overall effect of the valving arrangement is to reduce the length of the pump for improved economy and space saving. **Downwell Pump,** J. R. Brennan and P. S. Bloudoff, Patent No. 2,959,136.

Now . . . you're glad you called Halliburton

In cementing – fracturing – acidizing . . . regardless of the service your well needs, when you're ready to do the job that requires running a packer, you're *glad* you called Halliburton. Halliburton always gives top priority to the design, development and manufacture of its service tools and equipment.

This *built-in quality* is additional reason for the confident feeling you have when the Halliburton crew drives up to your lease. They bring experience of over *three million* service jobs with them.

Men, materials, experience . . . all working together make you glad you called HALLIBURTON.

FOR FURTHER INFORMATION ON
ADVERTISED PRODUCTS, SEE READER SERVICE CARD

RTTS PACKER...

Halliburton's Retrievable Test-Treat-Squeeze Packer is a good example of built-in quality. Since this multi-purpose tool is retrievable, valuable rig time can be saved with its use because *several* zones may be treated during one trip into the hole. Full opening design of the RTTS permits passage of perforating and other small tools. For added safety, the RTTS contains a built-in safety joint.

DM/DC SQUEEZE PACKER...

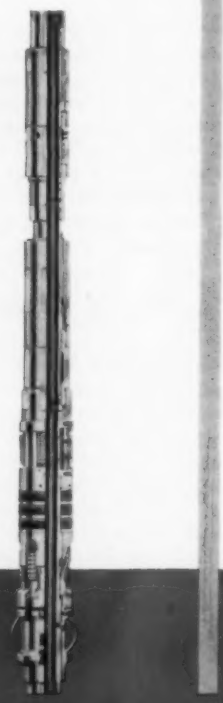
incorporates a built-in back pressure valve to help retain built-up pressures following a squeeze job. Safety in operation is another important feature since the tubing and circulating valve are completely freed from DM/DC packer prior to mixing cement or beginning other treating operations.

HM PACKER...

a full-opening hydraulic mechanical packer equipped with a built-in circulating valve. The HM Packer features simplicity of operation . . . tool is set by merely turning tubing to the right and slacking off weight. Following the job, picking up on tubing will release the packer for removal or re-setting.

CUP TYPE RETRIEVABLE BRIDGE PLUG...

the versatile Halliburton tool designed to hold pressure from either direction. Used separately or in conjunction with the RTTS or other Halliburton Packers, the combination arrangement becomes a straddle packer with unrestricted spacing. Also, since the tool is retrievable, it may be moved with the packer to straddle and treat several zones without round-tripping the tubing.



Don't settle for less than the best! Call Halliburton *first*. Your Halliburton man can help you select the best combination of tools and techniques to get the best results for your service needs.

The right tool is a Halliburton tool . . . every time!

SPECIAL TOOL SERVICES

Halliburton

COMPANY • DUNCAN, OKLAHOMA

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

A simple, reproducible method to . . .

Detect Sulfate Reducers and Evaluate Bactericides in Flood Water

FRANK YACKOVICH,
Armour Industrial Chemical Company, Chicago, Illinois

A SIMPLE, INEXPENSIVE, reliable and reproducible procedure for detecting sulfate-reducing bacteria in flood waters has been field tested with good results. The method also provides for evaluating bactericides against these organisms both in the field and in the laboratory. The procedure utilizes a modification of the old API formulated broth which was rendered anaerobic (the absence of air). Flood waters are sampled at definite points throughout the system in the field (Fig. 1). This water is then inoculated by means of sterile syringes into serum bottles containing the modified anaerobic API broth (see Fig. 2).

The broth bottles are inoculated in duplicate with water from each detection point in the system and are allowed to incubate at 35 to 37 C for 30 days, although results are generally obtained in 2 to 14 days.

Interpretation of results is rather simple. The broth bottles are observed for color development. A black-colored broth bottle indicates growth or the presence of sulfate-reducing bacteria, while a colorless bottle indicates the absence or control of sulfate reducers. An approximation of the number of sulfate reducers present in the flood water is made by means of the serial dilution technique.

Bacteria count is determined by observing which of the bottles darken and which do not. For example, if the serial dilution broth bottles 1, 1/30 and 1/900 turn black, but the 1/27,000 broth bottles do not blacken, it would mean that there are approximately 900 or more, but less than 27,000 sulfate reducers per milliliter of flood water. This is shown in Fig. 3. Broth bottles are labeled as multiples of 30, such as: 1, 1/30, 1/900, 1/27,000, 1/810,000 and 1/24,300,000.

Simplicity of the test procedure allows a person with no bacteriological background to successfully and aseptically analyze a flood water for the presence of sulfate reducers. It also enables him to evaluate bactericides, under field conditions, for the control of these organisms.

Preparing the Modified API Broth

The following chemicals are used to make up the modified API broth: 3.5 grams of calcium lactate; 1.0 grams of yeast extract; 0.2 grams of $MgSO_4 \cdot 7H_2O$; 10 grams of NaCl; 0.1 grams of $Fe(NH_4)_2(SO_4)_2 \cdot 6H_2O$; 0.1 grams of $FeSO_4 \cdot 7H_2O$; 0.1 gram of ascorbic acid; 1000 ml of distilled water.

These chemicals are dissolved in distilled water and, prior to sterilization, the pH is adjusted to 8.4. A 29-ml sample of the broth is added to a serum bottle containing a nail. A rubber stopper and aluminum seal are attached, and the broth bottle is then sterilized at 121 C and 15 psi for 20 min. The broth is cooled, and the pH is rechecked. If the pH is in the range of 7.0 to 7.4, then the remainder of the unsterilized broth is poured into a bottle containing a gas dispersion tube and a magnetic stirring bar.

Oil-pumped nitrogen is bubbled through the broth for at least 1 hour or more depending upon the quantity being prepared. Serum bottles containing an acid-cleaned iron nail are flushed with nitrogen for 10 seconds. Approximately 29 ml of the nitrogen-purged broth is poured into the serum bottles. The broth in the serum bottles is then blanketed with nitrogen for 10 additional seconds. Rubber stoppers and aluminum seals are then attached.

The broth bottles are then sterilized at 121 C at 15 psi for 20 minutes. A precipitate appears in the medium after sterilization. This is of little consequence since this medium is not used for a bacteriostatic test nor for colony counts but simply for growing the sulfate reducers.

Adding Bactericide to Serum Bottles

The effectiveness of certain bactericides in controlling sulfate reducers is determined in serum reaction bottles. These bactericides are added to the serum reaction bottles with a sterile tuberculin syringe. The bottles have previously been made anaerobic by purging with nitrogen and then sterilized at 121 C and 15 psi for 30 minutes.

Preparation of 3% NaCl Brine Water

A 3% NaCl brine water is made with the following materials: 30 grams of NaCl; 3.7 grams of $MgCl_2 \cdot 6H_2O$; 2.5 grams of $CaCl_2$; 1.7 grams of $MgSO_4 \cdot 7H_2O$; 0.06 grams $NaHCO_3$; 1000 ml of distilled water. The brine solution is adjusted to a pH of 7.2 with HCl prior to making the solution anaerobic and sterile.

After the pH has been adjusted, the brine solution is poured into a bottle containing a gas dispersion tube and a magnetic stirring bar. Oil-pumped nitrogen is bubbled through the solution for 1 hour or more depending upon the quantity being made. Serum bottles are flushed with nitrogen for 10 seconds. Definite volumes of the nitrogen-purged brine solution are added to the anaerobic serum bottles by means of an automatic burette. The brine solution in the serum bottles is then

Laboratory developed and field tested, a modified API broth made anaerobic is used in this improved technique that gives you some fast answers to potential corrosion and plugging due to sulfate-reducing bacteria in flood waters

FIG. 1. **Untreated flood water samples** are collected at various points throughout the system. Field test kit shown at right.

blanketed with nitrogen for 10 seconds before attaching the rubber stopper and aluminum seal. The brine bottles are then sealed and sterilized at 121 C at 15 psi for 20 minutes.

FIELD TEST PROCEDURE

The flood water, either treated or untreated, is allowed to run for 3 minutes before sampling. The anaerobic sampling jar is then carefully filled to the top with flood water (see Fig. 1). A sterile rubber stopper with a serum bottle seal attachment is aseptically pushed into the lip of the bottle. The sampling bottle is then shaken 30 times to distribute the microorganisms in the flood water. Using a sterile 2 ml syringe, one ml of the water sample is inoculated, in duplicate, into serum bottles containing the modified, anaerobic API broth (see Fig. 2). By serial dilution, using factors of 30, it is further diluted to 1/24,300,000. A new syringe is used at each dilution. This represents the zero time control. This control, conducted at the time of sampling, shows whether any sulfate reducers are present in the flood water and to what extent the system is contaminated.

If bactericides are to be evaluated, the rubber stopper is then removed from the sampling bottle. Thirty ml of the untreated flood water are then transferred with a sterile syringe and a pressure vent needle to the sterile, anaerobic 1 hour control serum bottle. The serum bottle is shaken 30 times and allowed to stand for 1 hour. The 1 hour serum control bottle is then shaken 30 times before inoculating one ml of this water, in duplicate, into the modified, anaerobic API broth. It is then diluted to 1/24,300,000 by the serial dilution method (see Fig. 2). The 1 hour control is compared with the zero hour control (untreated water) as a check on the bacterial population.

FIG. 2. **Anaerobic serum bottle** with modified API broth is inoculated with the untreated flood water.

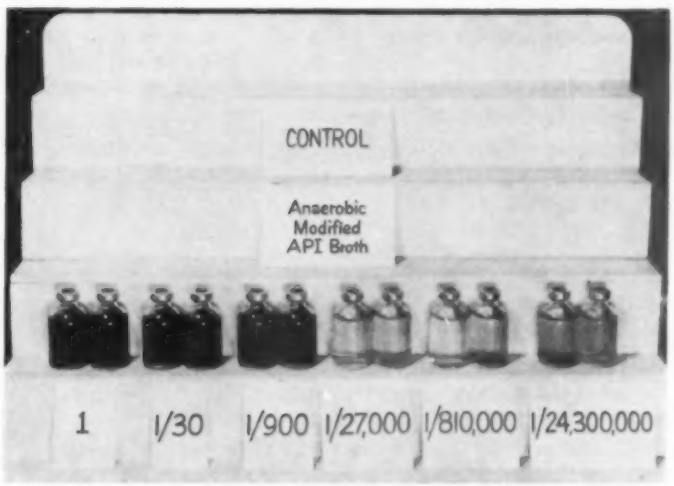


FIG. 3. **Presence of sulfate reducers** indicated by dark liquids in broth bottles. Extent of contamination is determined by serial of bottle. In this case, sulfate-reducing bacteria count is in excess of 900 but less than 27,000 per milliliter of flood water.

McCullough

PERFORATING SERVICES

Here's the most complete, most efficient line of perforating services available to the oil industry – all designed with one objective – to get more oil, *best* possible production!

Choice of the type perforating process to be used depends on the nature of the formation to be penetrated and the method of well completion; whether in full size casing, thru-tubing or in slim holes.

At McCullough you'll find bullet and jet guns, in a variety of types and sizes, to handle every requirement – quickly, efficiently and profitably – your *best* bet for *best* production!

FOR PERFORATING IN CASING

McCULLOUGH BULLET GUNS – World's hardest shooting bullet guns. Best available perforating process in all formations except extra hard.

McCULLOUGH GLASS JET GUNS – Most versatile and efficient of all jet casing perforators. Deep penetrating, carrot-free, junk-free. Uses flexible, retrievable Steel Strip Carrier. Gets best results in hard formation.

McCULLOUGH TUBULAR CASING JET GUNS – Star Jet, DuPont, Dynajet and Super Dynajet charges are available in most areas to meet varying well conditions.

TORPEDO JET GUNS, expendable type perforators for cased and open hole operations. Offered in limited areas.

FOR THRU-TUBING AND SLIM-HOLE PERFORATING

McCULLOUGH SECTIONAL BULLET GUNS – Only small diameter bullet guns made. Sizes are 1¼", 1⅝" and 2¼" OD. Backed by a record of more than 20 years of fine performance.

McCULLOUGH MAC-JET GUNS – Finest and most advanced of all small diameter, expendable jet guns. Features include enclosed firing system, minimum debris, deep penetration, high well flow index, carrot-free. Widely used in both thru-tubing and slim hole work.

OTHER SMALL DIAMETER GUNS include the **LINK JET** and **TORNADO JET,** expendable thru-tubing perforators; and the **SIDEWINDER,** a retrievable jet perforator for slim hole operations.

SPECIAL APPLICATIONS

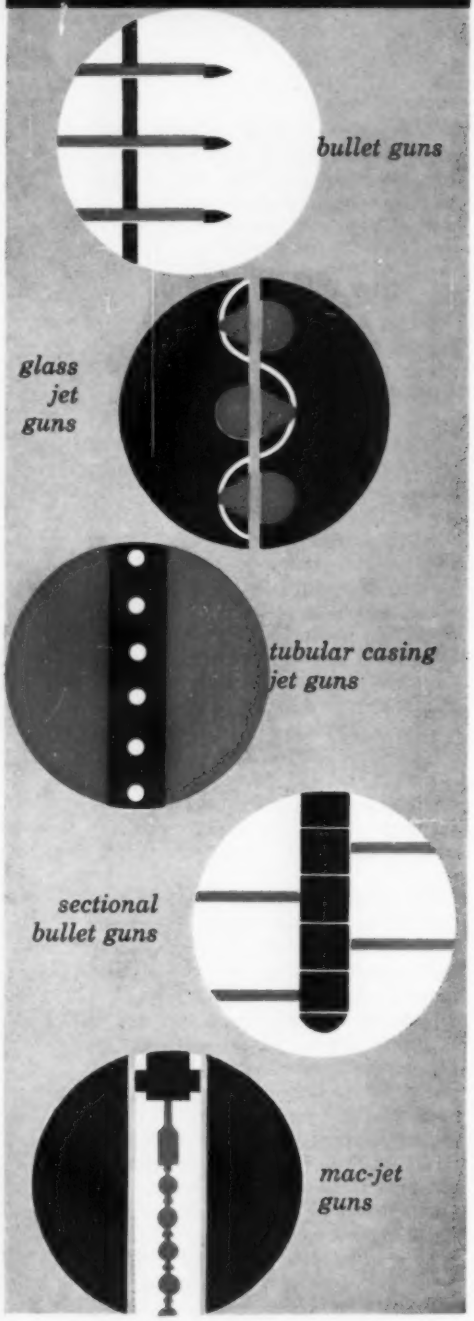
McCULLOUGH FOUR-WAY SQUEEZE JET GUNS – designed to assure even distribution of cement around casing. **FRAC-JET** – fires eight jets on a horizontal plane for fracture placement.

McCullough

TOOL COMPANY

Los Angeles • Houston • Edmonton • Cable Address: MACTOOL

your best bet for best production



FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

National Supply has everything you need for Spring Clean-Up

You'll find it pays to use your National Supply store as a single source for all your Spring clean-up needs. With one order you can cover all your needs . . . paint, hose, water cans, rig wash, paper towels, rakes, brooms, brushes, etc.

You'll save time by eliminating the need for visits or calls to several suppliers. One-order delivery will simplify your inventory control. And you'll be pleased with the wide variety of products and famous name brands you'll find at National Supply. We stock over 65,000 products, each made by a leading manufacturer with an established reputation for quality and reliability. All products are carefully selected with your needs in mind.

There are 119 of these National Supply stores strategically located to serve you as efficiently as possible. Next time you buy, see National Supply.

Why National units are today's

This is a National Supply pumping unit installed in West Texas. National pumpers are available in 13 basic sizes, with 148 standard specifications. Your National Supply representative can recommend a unit to meet your exact needs.

best pumper investment

LOW COST OPERATION. All features and parts of National pumpers are designed to give you low cost installation and operation. For example, National Supply provides frictionless bearings that measurably reduce fuel consumption. Ask your National Supply representative to show you how these frictionless bearings will save you money.

SPECIAL DESIGN FEATURES... at no extra cost. You get many "extra" features in National pumpers without paying premium prices. The entire National line is competitively priced. Here are a few of the features that are standard in National pumpers:

Accurate Counterbalancing. Geometric and concentric design of cranks and counterweights allow accurate counterbalance, at a leading or lagging condition as well as at mid-stroke. Counterweights can be quickly and safely adjusted by one man.

Two-Direction Gear Reducers. National gear reducers can be rotated in either direction, permitting more latitude on prime mover placement. This extends the life of the reduction unit.

Arc Hanger Design. Arc hanger has a hinge that can be folded back for unhindered well servicing. Self-adjusting features prevent side loading, polished rod bending and excessive wear of stuffing box packing.

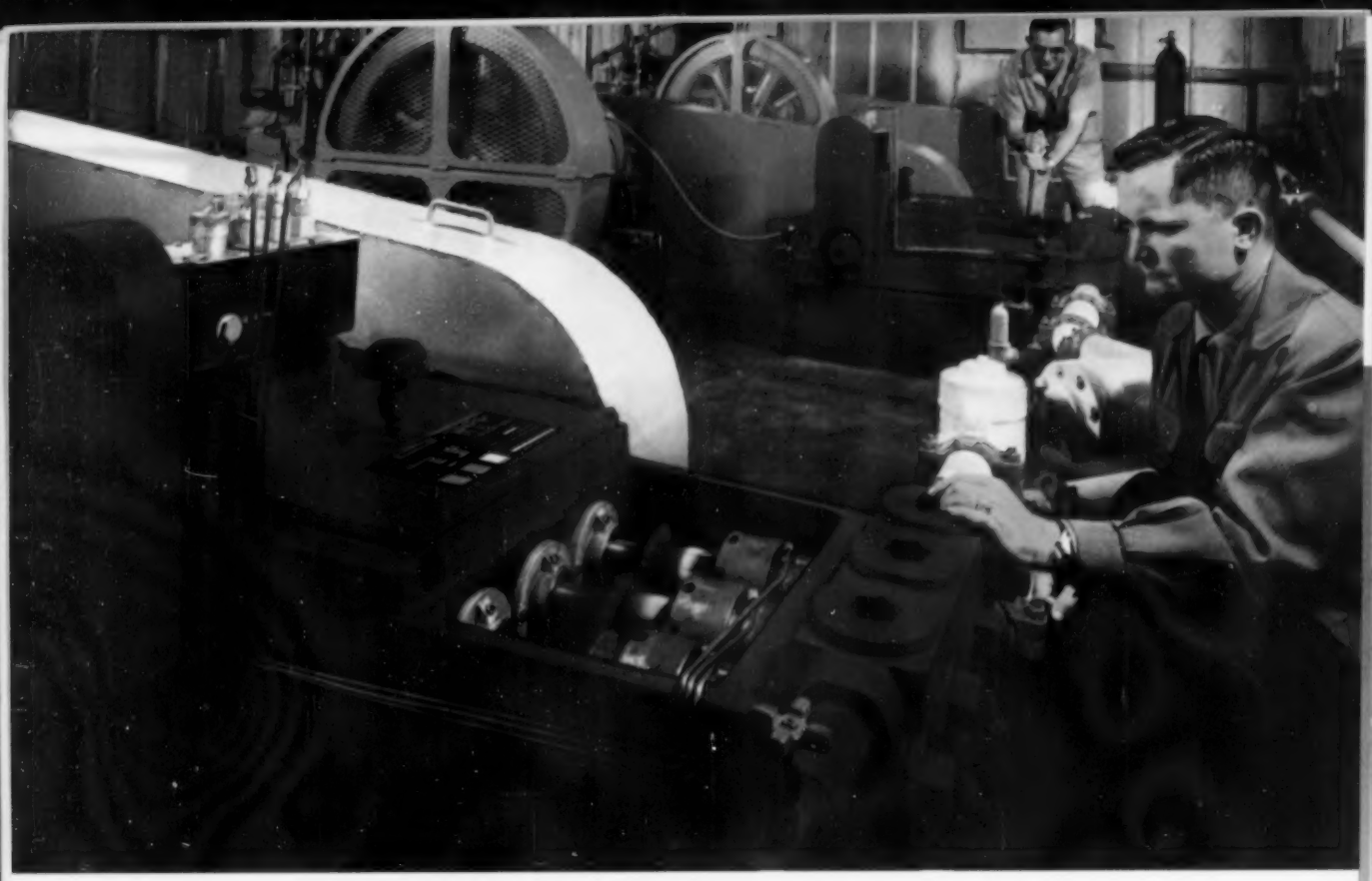
Dust Seals. National pumpers have dust excluders on all bearings to improve the life of oil seals and bearings. Dust seals on shafts rotate with, but do not touch, the shafts.

Unmatched Stability. National pumpers are less susceptible to twisting or stressing because of wide spacing of the samson post's four legs and cross bracing. Design distributes beam load evenly over entire foundation area.

National pumping units are available in 13 basic sizes with 148 standard specifications in beam and crank counterweighted types. They are structurally rated from 2,065 to 32,400 pounds on the walking beam. With this variation, there is never need to compromise on pumper size or rating. Ask your National Supply representative to recommend the ideal pumping unit to meet your specific requirements. Or write today for complete information from National Supply Division, Armco Steel Corporation, Two Gateway Center, Pittsburgh 22, Pa.

Steel's Symbol of strength, long life, and economy

Steel



The J-50 triplex pump has an integral suction pulsation dampener extending the full length of the fluid end, directly below the suction valves for maximum efficiency.

NEW NATIONAL J-50 TRIPLEX PUMP

for water flooding, power oil service and salt water disposal

The new National horizontal triplex pump is rated at 50 input horsepower for many applications such as water flooding, salt water disposal and power oil service.

You get low initial cost, plus a proven ruggedness and smooth operation with the J-50 triplex pump. Some of the many features are the built-in suction dampener, lightweight aluminum alloy connecting rods, and double extension crankshaft. A special fluid end can be specified for power oil service.

The J-50 triplex is available in three models: the J-50L and J-50M for low and medium pressures in corrosive and noncorrosive service, and the J-50PO for power oil service. Write for free literature on this versatile new pump to National Supply Division, Armco Steel Corporation, Two Gateway Center, Pittsburgh 22, Pa.

ARMCO National Supply Division

FIG. 4. **Test coupon** from flow line tee inserted into 8-oz. modified API broth bottle.

FIG. 5. **Scrapings from pipe** are also checked for possible occurrence of sulfate reducers even though water samples may not show their existence.

ABOUT THE AUTHOR

Frank Yackovich is senior bacteriologist at Armour Industrial Chemical Company's Research Laboratory, McCook, Illinois. A native of Binghamton, New York, where he received his elementary and secondary education, he served with the 3rd and 5th fleet carrier task force in World War II as a Naval aerial gunner. He received his BS in 1950, MS in 1955 and his PhD in 1959 in biology from St. Bonaventure University. He joined Armour in August, 1959 and has worked mainly with the bacterial problems of oil recovery.

After 30 ml of the untreated water sample has been added to the 1 hour serum control bottle, 30 ml of the untreated water sample are then added in a similar manner to the chemical reaction serum bottles.

The reaction bottles are then shaken 30 times and allowed to react for 1 hour. Using a sterile 2 ml syringe, 1 ml of the reaction mixture is inoculated, in duplicate, into the corresponding labeled serum bottles containing the modified API broth. The controls and reaction broth bottles are then incubated at 35 to 37 C for 30 additional days after the first control bottle turns black.

Tests on Metal Surfaces

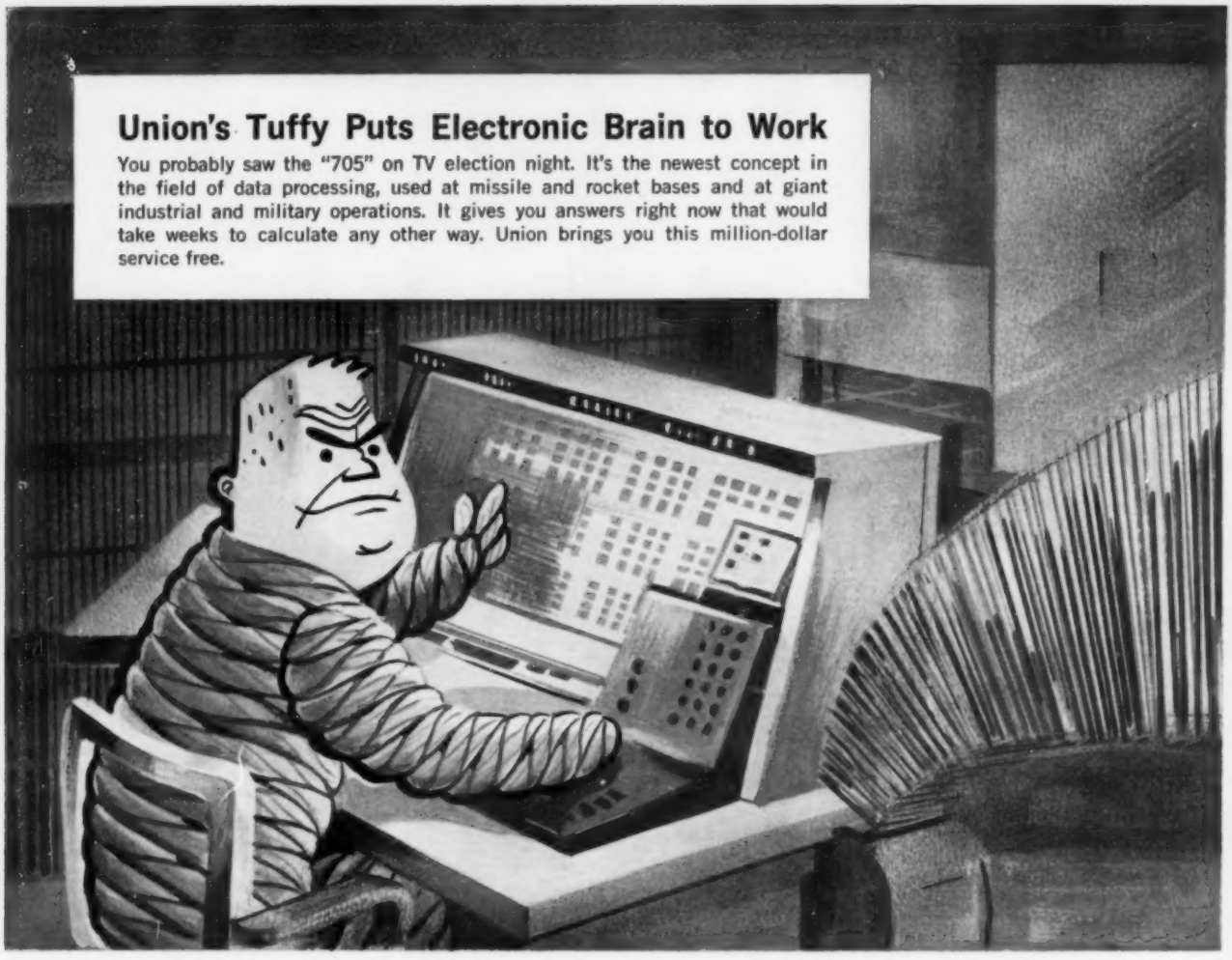
In our field work we noted that sulfate reducers were present on coupons installed in the system, even when the water itself gave no indications of being contaminated by sulfate reducers. This is understandable when one considers that these organisms prefer a solid surface for growth; one which lowers the oxidation-reduction potential and also provides them with a source of hydrogen. The iron pipe or coupon provides such a condition.

Whenever possible, coupons are installed in the untreated and treated water for two weeks to a month. The coupons are then carefully removed and new coupons are installed, as shown in Fig. 4.

The exposed coupons are placed in 8 oz bottles containing the modified API broth and vigorously shaken (Fig. 4). The coupons are then removed from the broth, dried, and saved for weighing. Serial dilutions are made of this broth by means of syringes and serum broth bottles containing modified API broth. All bottles are then incubated at 35 to 37 C for the prescribed length of time.

Sulfate reducers may be found growing underneath the corrosion products and debris attached to the pipe, even when the water appears to be free of contamination. As a result of this possibility, scrapings are removed from the pipe and analyzed for contamination by sulfate reducers. Consequently, contaminations are picked up which would otherwise go unnoticed. A definite area of the pipe is scraped and the scrapings are introduced into an 8 oz broth bottle and vigorously shaken (Fig. 5).

Serial dilutions are made in the pre-


Union's Tuffy Puts Electronic Brain to Work
You probably saw the "705" on TV election night. It's the newest concept in the field of data processing, used at missile and rocket bases and at giant industrial and military operations. It gives you answers right now that would take weeks to calculate any other way. Union brings you this million-dollar service free.

Union Tuffy Made 600,000 Calculations

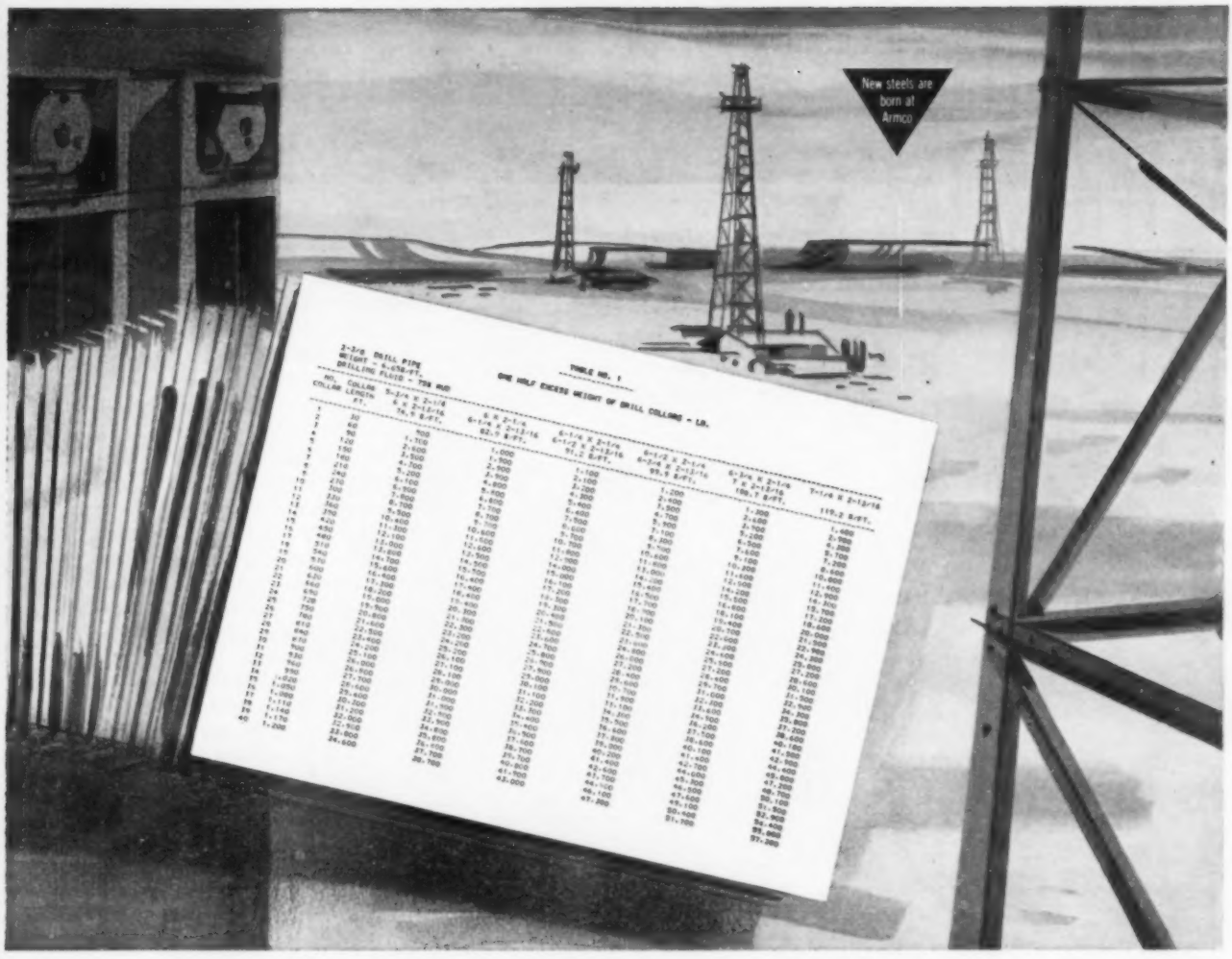
Accurate ton-mile tables now available for practically every drilling situation. Using the advanced IBM "705," Union has improved the rotary line cut-off procedure.

It all started 12 years ago before electronic brains were developed. In 1952, after 3 years work with company field men, major oil companies and drilling contractors, Union brought out a workable cut-off practice for rotary drilling that has become standard practice throughout the industry. It has helped drillers of oil wells get more service and save money on wire rope and to avoid down-time and costly fishing jobs.

Next step is the improved Union Electronic Cut-off System. No more slide rules. The figuring is all done for you in advance—some 600,000 calculations. They take into account all the variables such as drum diameters, derrick heights, drill collar and pipe sizes and weights, rope diameter, design factors, mud or air drilling, etc. Quickly, you select the correct ton-mile chart and know how and when to cut rope for safe maximum service for any drilling situation—for wells down to 25,000 feet.

In operation it's very simple. We don't ask you to wade through the big mass of figures. Just tell us the basic facts about your drilling operation. We'll send a field man to the job site with the few specific tables you need and full instructions to pin-point your answers.

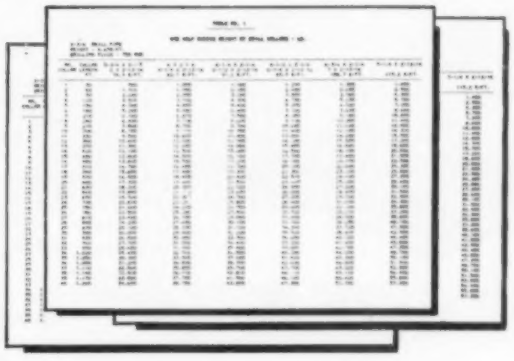
Quickly Available... Tuffy Standard Rotary Line and Tuffy Jackknife Rotary Line and the standard Union Oil Well Servicing Ropes cost less to use in the long run. Quick delivery from leading oil field supply stores the world over.



To Give You The Ton-Mile Answers

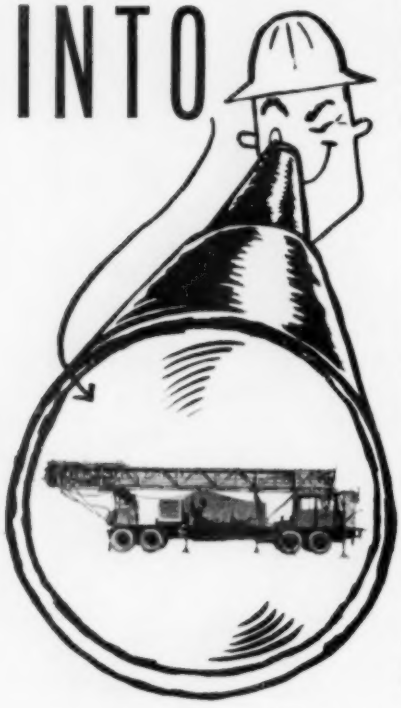
New Personal Field Service

A new person to person engineering service comes with Union's Electronic cut-off procedure. Just outline your drilling plans. A qualified Union fieldman will bring you the charts you need—5 or 6 simple charts usually —and explain their use to you and your entire crew. Write or wire **Union Wire Rope, Armco Steel Corporation, 2106 Manchester Ave., Kansas City 26, Missouri**



ARMCO Union Wire Rope

WORTH LOOKING INTO



Get the facts about—

WINCHMOBILE

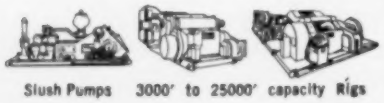
Before you buy get the facts on light weight...low cost...long life Wilson Winchmobile with the cross mounted engine which saves moving parts and increases hp to the drum by 20%!

Wilson

WILSON MFG. CO., INC.

Wichita Falls, Texas • The Home of RED IRON

Winchmobiles Traveling Blocks Speedwinches



Slush Pumps 3000' to 25000' capacity Rigs

scribed manner. All bottles are incubated at 35 to 37 C.

In rechecking a flood water for sulfate-reducing bacterial contamination, two controls are taken, one of the untreated and the other of the treated water.

Chemicals Evaluated in Lab

The procedure for this test is the same as for the field test, with the following exceptions: In the laboratory tests, the sterile anaerobic 3% NaCl brine solution plus the sulfate-reducing culture replaces the flood water as the inoculum.

For the controls, 0.3 ml of a 5-day old sulfate-reducing culture is added with a 1 ml tuberculin syringe to 29.7 ml of the sterile anaerobic 3% NaCl brine water. For the chemical evaluation, definite volumes of a stock chemical solution are added to definite volumes of the anaerobic, sterile 3% NaCl brine water by means of a tuberculin syringe and then shaken 30 times. Three tenths ml of the 5-day old culture are added to the mixture and the reaction bottle is again shaken 30 times.

The 1 hour control and the inoculated reaction mixtures are placed in a constant temperature water bath at 25 C for 1 hour. Then one ml aliquots are inoculated in the corresponding labeled broth serum bottles, in duplicate, from each reaction bottle.

In all cases, all bottles are shaken 30 times upon the addition of an inoculum and before withdrawing an inoculum.

DEVELOPMENT OF METHOD

Prior to the development of Armour's modified, anaerobic API broth and anaerobic technique[1], field trips were taken to analyze flood waters for the presence of sulfate reducers. The method used was essentially the same as that suggested by Allred[2] with the exception that serum bottles were employed and an old formulation API broth was used. On more than one occasion, failure was experienced in initiating growth of the sulfate reducers from flood waters which contained a hydrogen sulfide odor and iron sulfide. In cases where growth was initiated, large variations in test results were obtained. In the field it was difficult to establish whether this failure was due to the technique or to the medium itself[3]; consequently, experiments were conducted in the laboratory to correct this situation.

In the preliminary experiments as in the later ones, it was noted that the old formulated API broth gave results as good as the current API broth[4]. As a result of this finding, improvements were made upon the old formulated API broth until it became a sensitive and reliable broth for laboratory and field work. Experiments were conducted to determine the survival time of the sulfate-reducing culture in different types of water. It was noted that this culture did not survive a 2-hour exposure to air in distilled water.

Any pure or mixed population of microorganisms contains organisms of varying resistance within the population to certain adverse environmental conditions[5,6]. It was decided to eliminate as many of the unfavorable conditions as possible for growing these organisms and for testing.

In the chemical evaluation experiments in the laboratory, anaerobic conditions were maintained, the pH selected was 7.2, which is in the optimum range for the growth of these organisms, and a brine solution was selected that approached the average "hardness" one might expect to find under actual field conditions.

It is known that there are many chemicals that have optimum activity in pH ranges that are not conducive for the growth of the sulfate reducers. If an evaluation is conducted under these pH conditions, the chemical appears to be very effective in the laboratory but fails in the field. A factor that should be considered when evaluating any results is how closely do the test conditions approach the field conditions?

In the field, this problem simplifies itself, since flood water is used as the inoculant. Even here, anaerobic conditions should be maintained, if possible, during all phases of the experiment.

Armour's modified API broth and anaerobic technique have been tested successfully in the laboratory and in the field for nearly a year.

References

1. Yackovich, F., "Method ABP-3-1960, Armour's Anaerobic Field Testing Procedure for Sulfate Reducers." Armour Industrial Chemical Company, Division of Armour and Company, Petroleum Research Section, Bacteriological Group: 2-12, 1960.

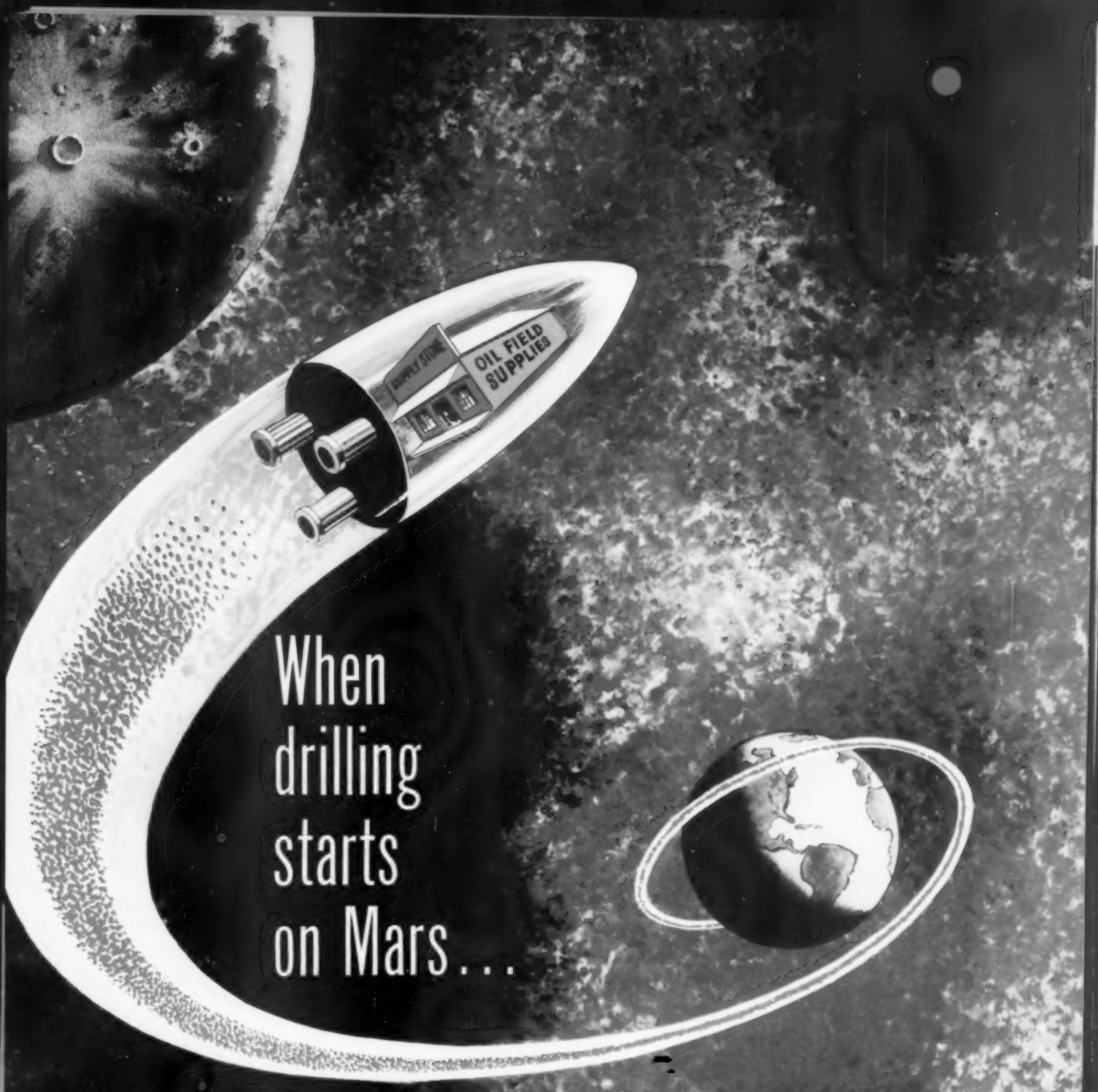
2. Allred, R. C., "Methods Used For Counting of Sulfate-Reducing Bacteria and For the Screening of Bactericides." Science Symposium, Sulfate Reducing Bacterial Their Relation to the Secondary Recovery of Oil, St. Bonaventure University: 52-60, October 23-24, 1957.

3. Postgate, J. Discussion following lecture. Science Symposium, Sulfate Reducing Bacteria Their Relation to the Secondary Recovery of Oil, St. Bonaventure University: 56-59, October 23-24, 1957.

4. "Recommended Practice for Biological Analysis of Water-Flood Injection Water" — API RP 38, First Edition: 3-6, May, 1959.

5. Anderson, K. E., and Yackovich, F., "The Effect of Bactericides on the Microorganisms in Oil Flooding Waters." Science Studies 17: 33-63, October, 1955.

6. Yackovich, F., "The Effect of Bactericides Upon Microorganisms Isolated From Oil Flood Waters." Master of Science Dissertation, St. Bonaventure University, April 25, 1955. ★ ★



When drilling starts on Mars...

Sound fantastic? Hold up a minute. Plans already have been made to drill on the Moon, and soon. We'll agree that more cheese may be found than oil, but if oil *is* found supplies will be needed. And, as always, your OIL FIELD SUPPLY STORES will be ready to do the job.

For availability and convenient job location, you just can't beat an OIL FIELD SUPPLY STORE. On Earth or on Mars, we urge you to take advantage of their fast and efficient services.

W. C. NORRIS DIVISION

DOVER CORPORATION

P. O. BOX 1739 • TULSA, OKLA.

Security's going up!

Security continues to capture more and more of the rock bit market... *proof-positive* that Security is moving up... a good reason why you should specify Security in your bit program. Check these reasons why *you'll profit!*

UP IN SECURITY FIRSTS: The *first* patented NAIL LOCK for jet nozzles, the *first* Extended Jet, 2-cutter bit, and the *first* 'extended' jet nozzle.

UP IN SALES: Even with the current industry tempo, Security sales have risen. Bit quality and years-ahead engineering are major factors in this growth.

UP IN CUSTOMER PREFERENCE: From Canada to Caracas, from the Mid-Continent to the Middle East... more and more, Security is *the* bit specified.

CONTINUALLY UP IN QUALITY: Every Security bit has that *extra* built-in bite, created by tomorrow's engineering *today!* Continued field and laboratory research improve design and bit performance.

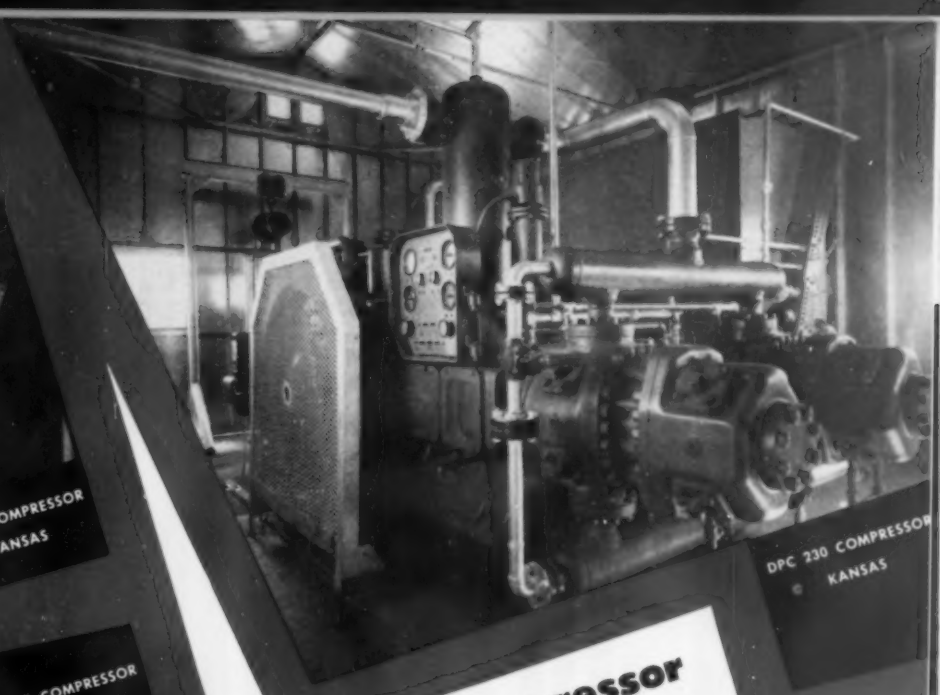
Write today for new all-products catalog.

Security®

ENGINEERING DIVISION
P. O. Box 13647 Dallas, Texas

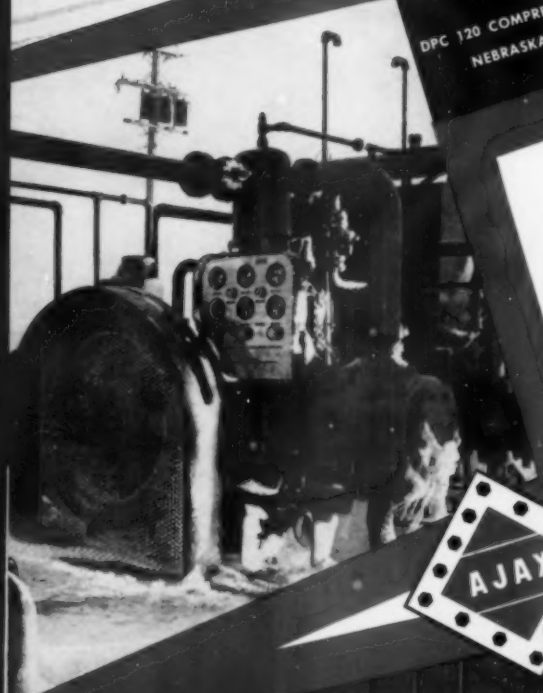
DRESSER INDUSTRIES, INC.

DPC 115 COMPRESSOR
ARKANSAS



DPC 230 COMPRESSOR
KANSAS

DPC 120 COMPRESSOR
NEBRASKA



Over 50 compressor sales with 12 repeat orders the first 18 months

THERE IS NO FINER TESTIMONIAL THAN REPEAT SALES TO SATISFIED CUSTOMERS

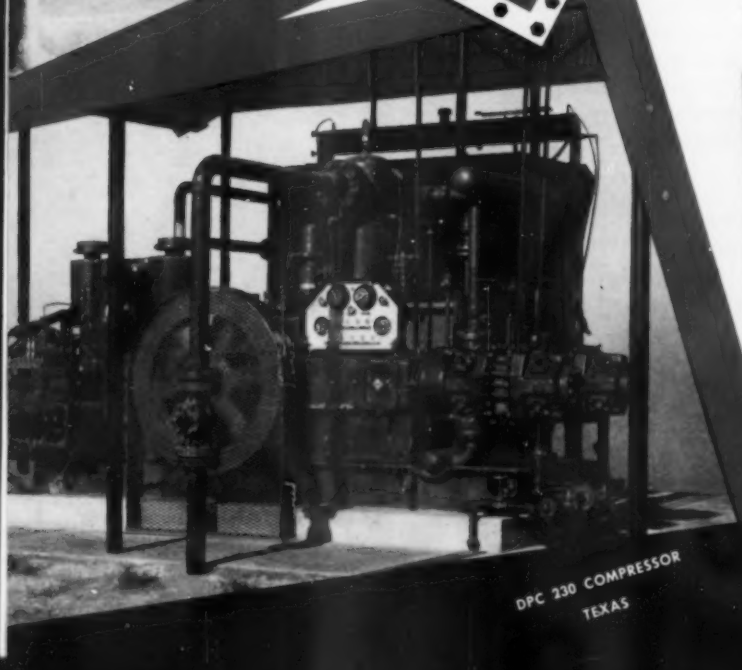
Ajax has been selling its new compressors for a little more than 18 months. 12 of these large unit buyers have re-ordered additional units.

The craftmanship, quality, and integrity of the Ajax name carries through the entire line of pumps, compressors, and engines. Let us work with you to determine the right unit to do the best job.

AJAX IRON WORKS CORRY, PENNSYLVANIA

Oil Field Distributors

- The National Supply Co. — Pittsburgh, Pennsylvania
- Bethlehem Steel Co. — Supply Division, Tulsa, Oklahoma
- Mid-Continent Supply Co. — Fort Worth, Texas

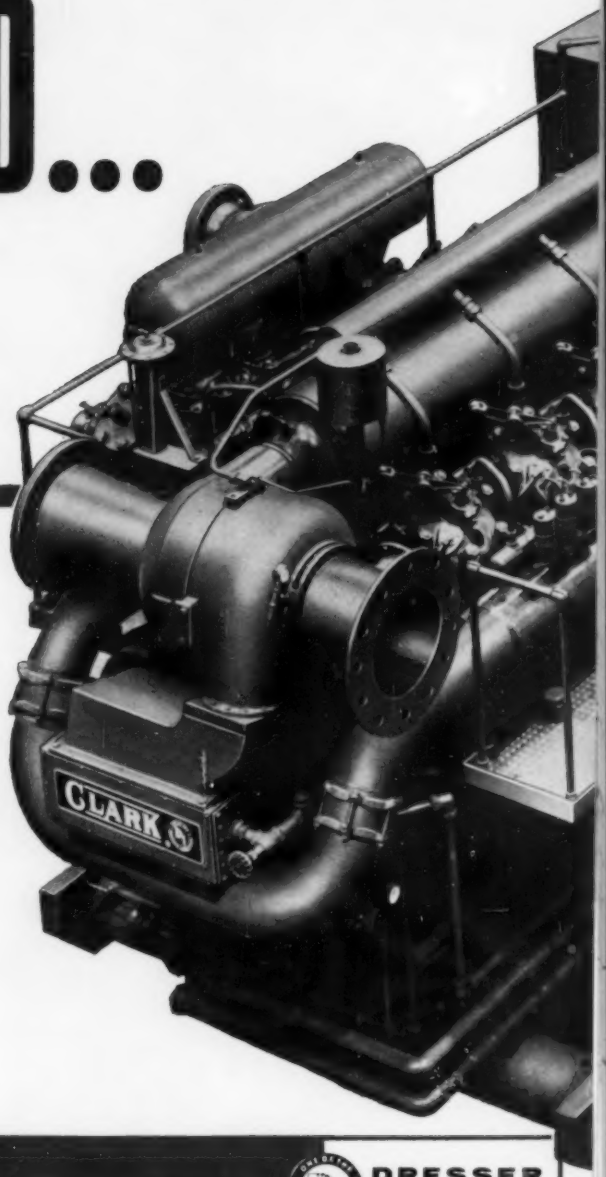


DPC 230 COMPRESSOR
TEXAS

DPC 115 COMPRESSOR
CALIFORNIA

NEW by CLARK

1000 bhp COMPRESSOR ON 35 ft SKID... COMPLETE!



It's called the Clark **VeePac** and you can see at a glance that here is the most compact, most versatile, most long-lived packaged compressor available today. Now you can have a unit up to 1000 bhp complete with radiator and all accessories mounted on a single skid only 35 feet long.

Designed For Field Service, offshore platforms and process use, the *VeePac* combines V-Engine compactness with the known reliability and simplicity inherent in Clark 2-Cycle design. The use of large blocks of horsepower in one package affords new savings in space, total units required, installation costs and operating expense.

Versatility is a key feature. Depending on the service, the *VeePac* can be equipped with compressor cylinders on one or both sides of the crankcase. For low suction pressure applications, as many as six large compressor cylinders can be used.

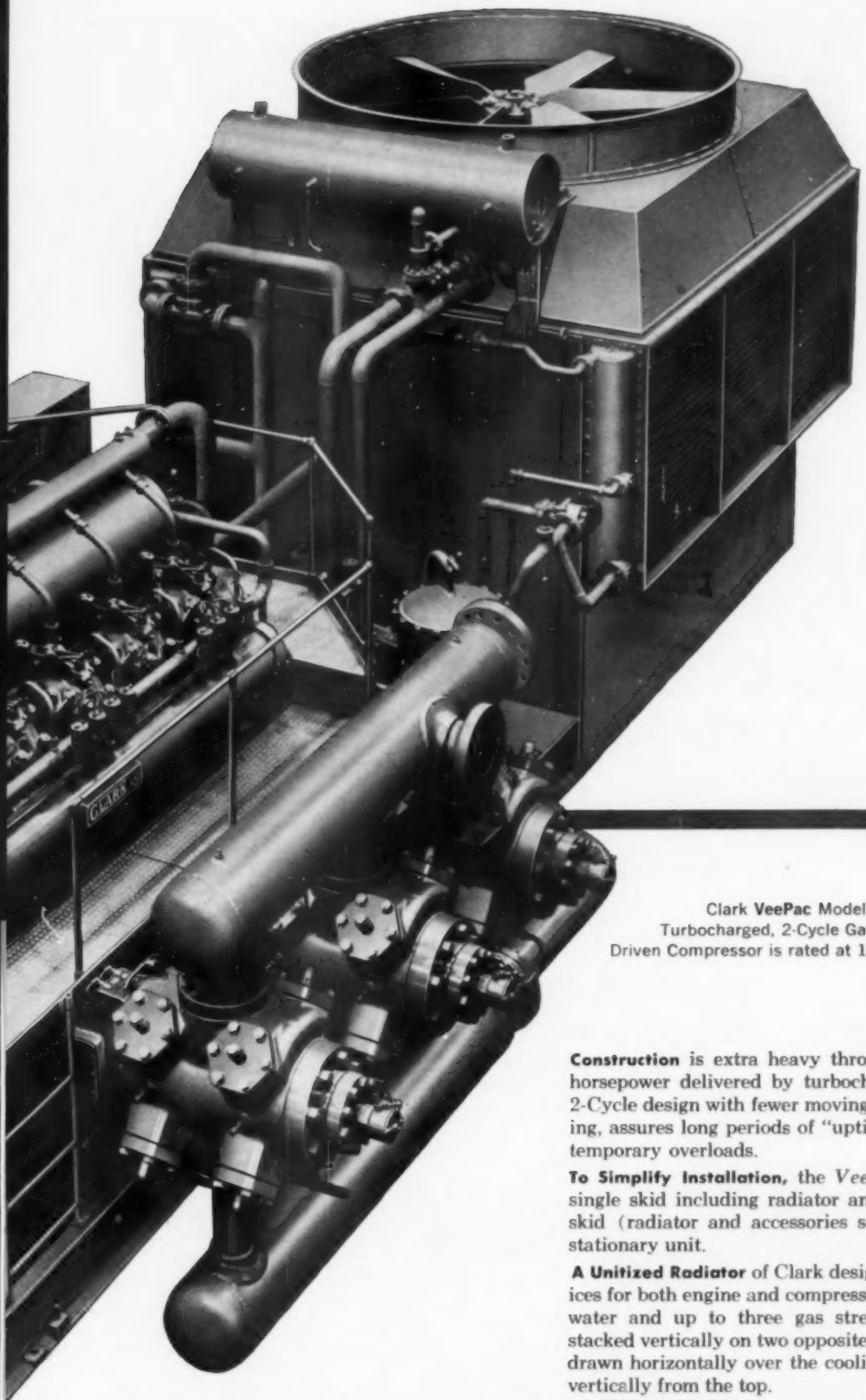
A Constant Pressure Turbocharger packs vast amounts of scavenging air into the combustion system, thereby boosting power output, reducing fuel consumption and lowering cooling duty. Completely automatic in operation, it tailors the air supply to engine demands over the entire operating range.

Variable-Speed, Variable-Load applications present no problem. An automatic ignition timing control combines with the turbocharger to provide exceptionally good response, good speed control, and low fuel consumption over a wide range.

CLARK

DRESSER INDUSTRIES INC.
OIL • GAS • CHEMICAL
ELECTRONIC • INDUSTRIAL

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



Clark **VeePac** Model TVM-12, Turbocharged, 2-Cycle Gas-Engine-Driven Compressor is rated at 1000 bhp.

Construction is extra heavy throughout to handle the high horsepower delivered by turbocharging. In addition, Clark 2-Cycle design with fewer moving parts and conservative rating, assures long periods of "uptime" plus ample reserve for temporary overloads.

To Simplify Installation, the *VeePac* can be mounted on a single skid including radiator and all accessories, a duplex skid (radiator and accessories separate), or supplied as a stationary unit.

A Unitized Radiator of Clark design provides all cooling services for both engine and compressor including lube oil, jacket water and up to three gas streams. Cooling sections are stacked vertically on two opposite sides of the radiator. Air is drawn horizontally over the cooling surfaces and discharged vertically from the top.

Available in Two Sizes—10 and 12 power cylinders rated at 825 and 1000 bhp respectively, the Clark *VeePac* Model TVM is designed to help you boost the efficiency of every compressor dollar you spend. For full information, contact your nearest Clark office or write for new illustrated Bulletin 191.

CLARK BROS. CO.

OLEAN, N. Y.

Engines Compressors Gas Turbines

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Typical A Valve Test Case History — No Pressure Loss

TYPE A FLOW VALVE

GUIBERSON'S *Type A Flow Valves are Proved Perfect Before Shipping*

Every Guiberson flow valve is pressured, then put through periodic opening and closing tests to assure operational efficiency. Each valve is electronically checked with a leak detector so sensitive it detects leaks as small as one ounce per hundred years. Guiberson valves are known to be perfect before shipping.

This unique method of quality control is the reason why Guiberson flow valves have built-in reliability.. costly pulling jobs for valve repairs are cut to the minimum. It's the reason why experienced operators say these valves have the lowest number of returns in the industry.

Guiberson's Type A Control Valves produce continuous or intermittent flow with only surface adjustment. Designed and engineered for superior performance, with tungsten carbide ball and seat that last for years. Corrosion and erosion resistant construction throughout — no rubber, no plastic, no O-rings to deteriorate.

Guiberson's Type AW Valve Is Available for Wire Line Installations. The Type AW, with integral check valve and special mandrel, lets you run in and retrieve on wire line.

THE GUIBERSON CORPORATION

ESTABLISHED 1919

DALLAS, TEXAS U. S. A.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

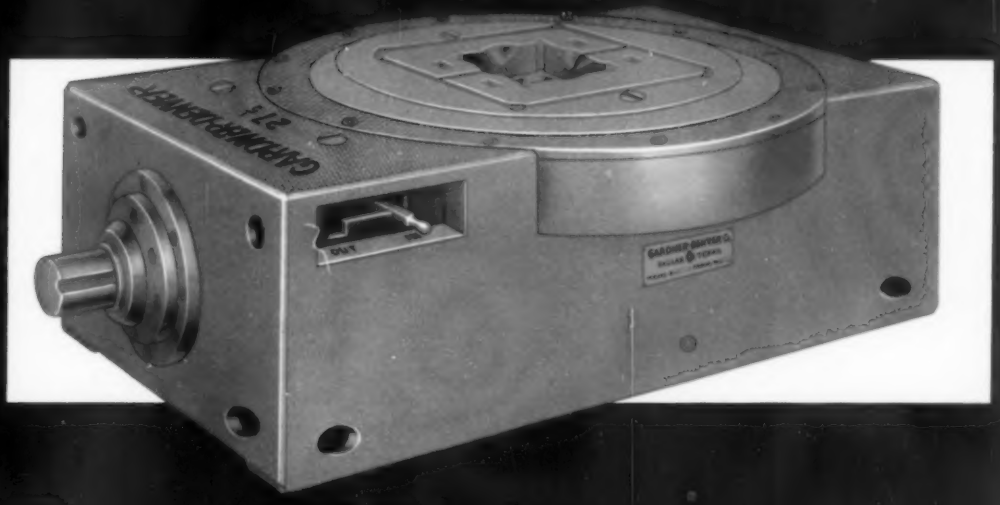
with faith in the oil industry's future . . .
GARDNER-DENVER MAKES THE NEWS

GARDNER-DENVER
Since 1859

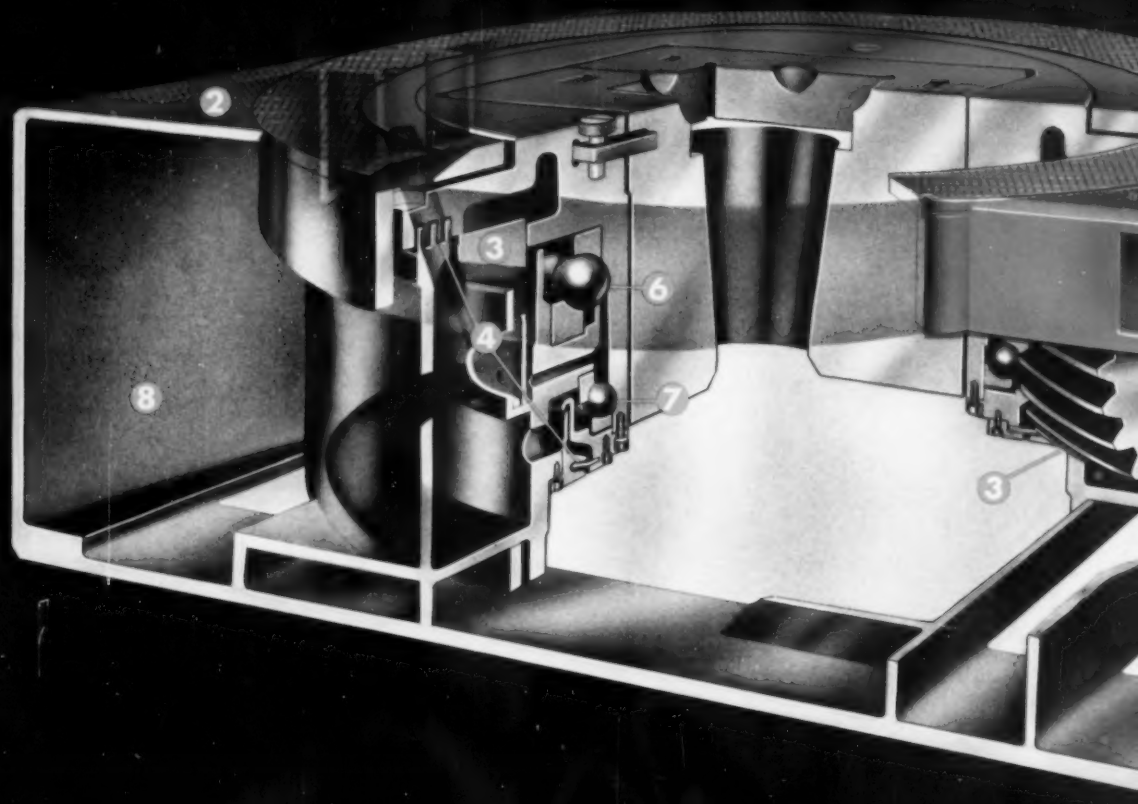
new . . . rotary tables

for the drilling industry

ON THE OUTSIDE all rotary tables look much alike. But take a look inside Gardner-Denver's new rotary tables. Check them point by point against any others existing. Compare every creative-engineered component. See how Gardner-Denver builds newness into rotary tables to provide smooth performance, longer maintenance-free operation. Fold out the page and you'll see that . . .



It's what's inside that counts



Inside view demonstrates

1. Dual locks for make-up or break-out—table ratchets to left or right, or locks in fixed position. Safety-positioned below floor plate.

2. Safe, nonskid floor plate—1" steel plate is free of projecting bolts or filler plugs. Provides safety to drilling crew.

3. Turbo-lubricated ring gear and pinion—flood of oil lubricates ring gear and spiral bevel gear. Gears are matched and lapped for smooth operation.

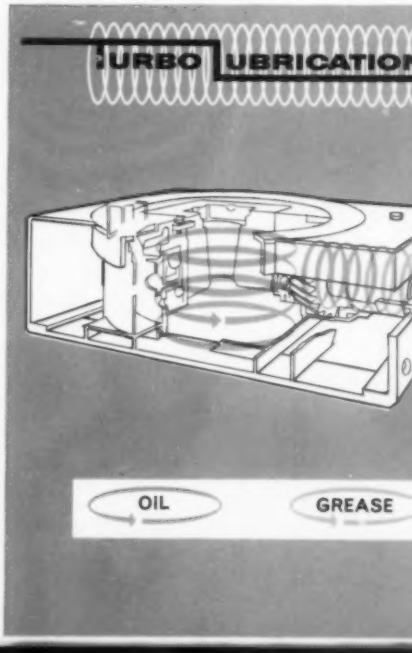
4. Efficient oil seals protect internal working parts—triple-labyrinth upper seal and positive lower seal protect gears and bearings from foreign material. Close-fitting oil seal protects pinion bearings.

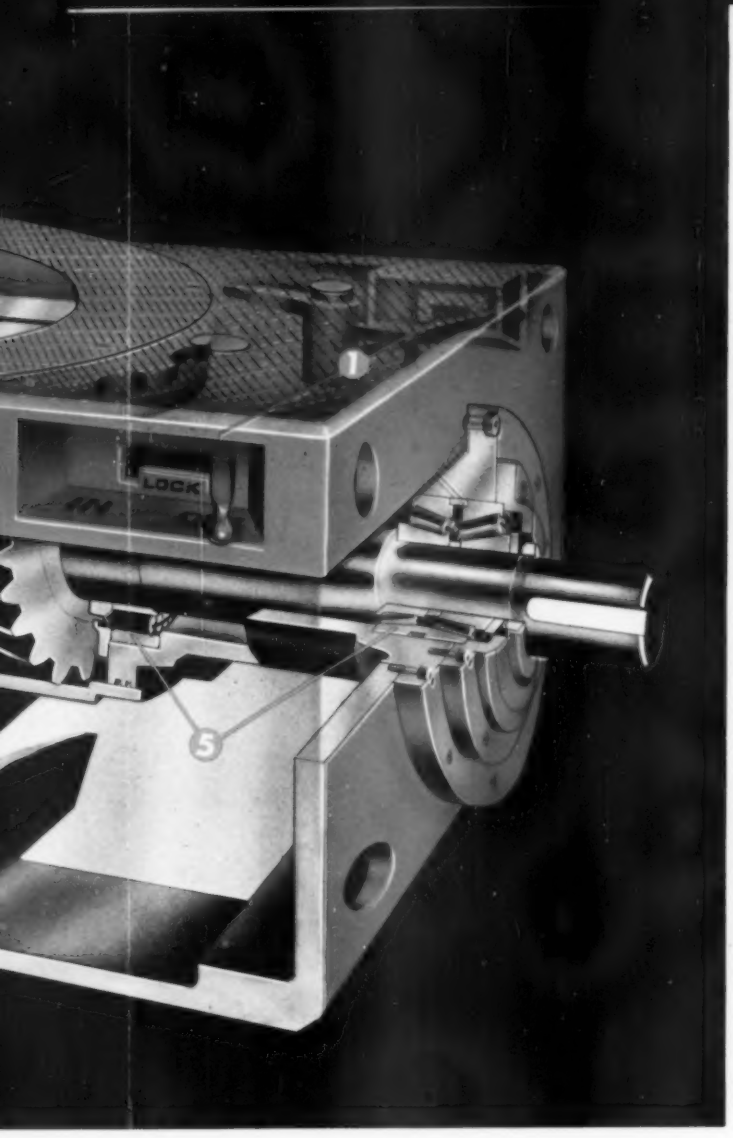
5. Individually lubricated pinion bearings—direct grease application to each bearing assures positive lubrication under heavy shock loads. Grease fittings are grouped near the oil filler plug. Straight and tapered heavy-duty roller bearings have been combined on the pinion shaft assembly to handle heavy thrust and radial loads.

6. High-load-capacity main bearing—highest quality, engineered to Gardner-Denver specifications. Balls run in hardened steel races. All Turbo-lubricated and cooled by a constant circulation of oil.

7. Ball-type hold-down bearing—holds table and gears in accurate alignment under heaviest loads. Elimination of slack protects gears from chatter and wear. Turbo-lubrication carries away heat and extends bearing life.

8. Streamlined, fabricated steel housing—ruggedly built of steel plate. Stiffener plates and ribs add rigidity at high-stress points for maximum strength.





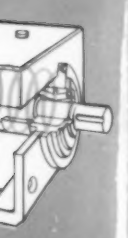
Complete line of matched rig equipment for economically drilling 4,000 to 30,000 feet

DRAWWORKS	ROTARY TABLES	TRAVELING BLOCKS	SWIVELS
GD 500 HP	17½" 234 Tons*	125 Tons*	125 Tons*
GD 700 HP		200 Tons	200 Tons
GD 1100 HP	22½" 378 Tons	300 Tons	300 Tons
GD 1500 HP		400 Tons	400 Tons
GD 2100 HP	27½" 432 Tons	550 Tons	550 Tons

**Dead load capacity*

s Gardner-Denver superiority

ON



SE

ONLY GARDNER-DENVER rotary tables have Turbo-lubrication to increase the life of working parts. Turbo-lubrication cools and lubricates every moving part with a fast-moving stream of oil. Oil picked up from the large reservoir by the pinion gear is force-circulated by the ring gear—then centrifugal action speeds the oil flow and distributes it evenly over the gears and main bearing. As the oil returns to the reservoir, it cascades over the hold-down bearing. This large volume of cool oil adds thousands of hours of maintenance-free service to Gardner-Denver rotary tables.

GARDNER-DENVER Since 1859

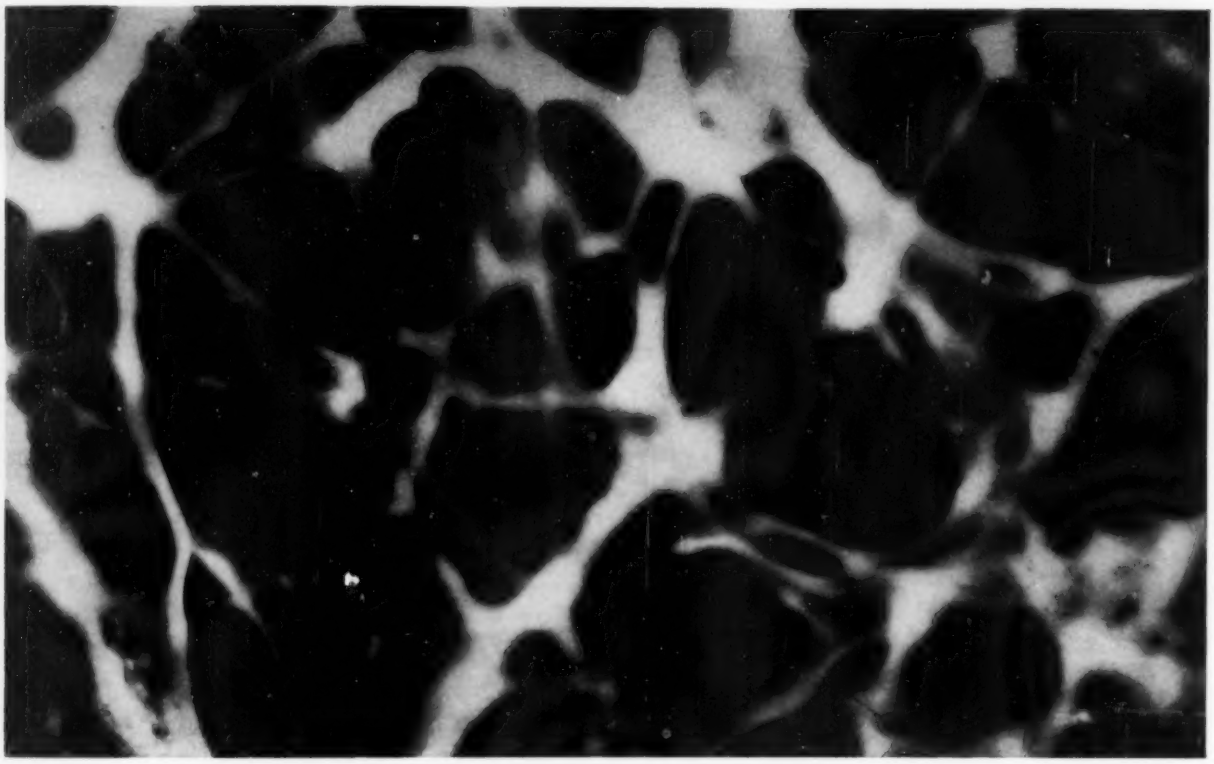
EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER-DENVER

Gardner-Denver Company, Quincy, Ill.—Offices in principal U.S., Canadian and Mexican cities.
In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario.

International: Gardner-Denver International Division, 233 Broadway, New York 7, N.Y.
Offices: Buenos Aires, Argentina; Artarmon, N.S.W. Australia; Brussels, Belgium; Rio de Janeiro, Brazil; Santiago, Chile; Barranquilla, Colombia; Lima, Peru; Ndola, N. Rhodesia; Salisbury, S. Rhodesia; Johannesburg, Transvaal

LITHO IN U. S. A.



electron micrograph shows why Slick Water reduces pumping horsepower losses during well treatments

This electron micrograph shows an 11,000-time magnification of the polymer in Slick Water*, Dowell's friction-reducing agent for water. An agent providing a similar effect is also available for acid. ☐ Notice the structure of the polymer. It is believed that the polymer confers an elastic behavior which suppresses the usual turbulence of fast-flowing fluids. This action saves much of the energy lost by random turbulent motion and reduces friction in the pipe.

This means lower fluid friction and greater pumping efficiency

What can Slick Water do for you? It all depends on your well and your treatment requirements.

In some cases, it means that you may need only one pump truck instead of three for fracturing or acidizing. You pocket the saving!

In some cases, it may mean that you can get the benefits of high-injection-rate fracturing without having to pull tubing.

In other cases, it may mean that you can attain desired injection rates, yet stay within the pressure limit set by the strength of the casing.

In still other instances, it may mean that you can perform larger, higher-rate treatments and profit from bigger production increases.

And sometimes, it may mean that you can use a lower cost fluid – again reducing treatment costs.

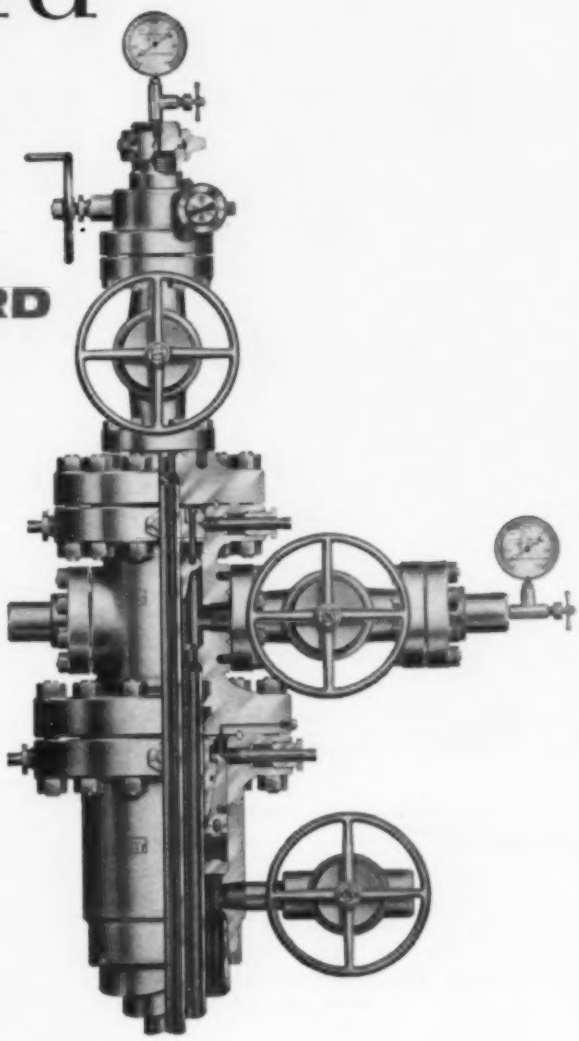
Dowell friction-reducing agents have helped operators get lower treatment costs and greater production increases. As your Dowell representative for more information. Dowell services and products are offered from more than 150 offices and stations in the United States, Canada, Venezuela, Argentina, Germany, France and the Sahara area. Dowell, Tulsa 1, Oklahoma. *DOWELL TRADEMARK

SERVICES FOR THE OIL INDUSTRY

DOWELL

DIVISION OF THE DOW CHEMICAL COMPANY

The O·C·T Standard Tree



STILL THE "STANDARD OF THE OILFIELD"

The O-C-T Standard Tree is a combination of an O-C-T casing head, O-C-T tubing head, master valve of your choice, and an O-C-T flow control.

Thousands of O-C-T Standard Trees are performing in oilfields around the world. The strength, simplicity, and flexibility of the Standard Tree made it the "standard of the oilfield" years ago.

Constant improvements to the O-C-T Standard Tree have made a good tree better. Today, more than ever, informed buyers can say, "There is no better hookup."

where progress is a daily practice

O·C·T

OIL CENTER TOOL CO.

SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

Address Export Inquiries for All Countries to
P. O. Box 3091, Houston, Texas.

"A great step forward with your Planetary Gears, Big Bearings and Cylindrical Crossheads."

— J. K. Butler

WHELAND PLANETARY
HP-16000 PUMP
Duplex Power Slush Pump
7¾" x 16", 600 H.P. at 65 RPM

OIL PRODUCTION MAINTENANCE, INC.
7440 CHOCOLATE BAYOU ROAD -- P. O. BOX 14291
HOUSTON 21, TEXAS
August 31, 1960

Mr. Gordon P. Street, President
The Wheland Company
Chattanooga, Tennessee

Dear Mr. Street:

Our Wheland Planetary Pump is giving us increased penetration and good savings on bits. We know from more than 18 months of constant operation on 10,000 Ft. wells that our savings are substantial.

We have kept an accurate record on operating costs and all maintenance costs and are especially impressed by the low cost of fluid end expendables. The HP-16000 Pump has constantly operated near its rated capacity on more than 200,000 feet of hole in the Texas Gulf Coast Area.

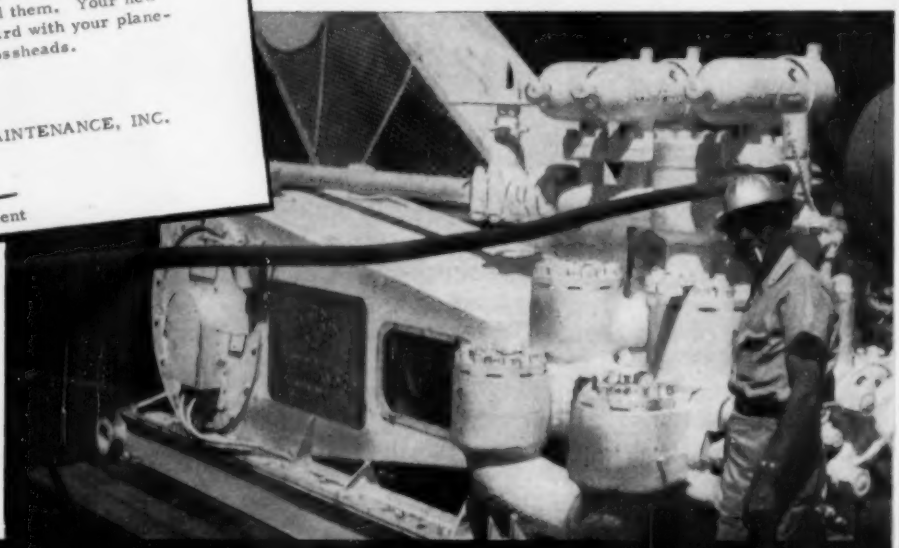
We are now operating Wheland HP-18000, HP-14000, and HP-16000 Pumps and are glad to recommend them. Your new HP-16000 Pump design is a great step forward with your planetary gears, big bearings and cylindrical crossheads.

Yours very truly,

OIL PRODUCTION MAINTENANCE, INC.

J. K. Butler

J. K. Butler, President



Wheland HP-16000 Planetary Pump owned by Oil Production Maintenance, Inc., on location in the Gulf Coast area.

WHELAND

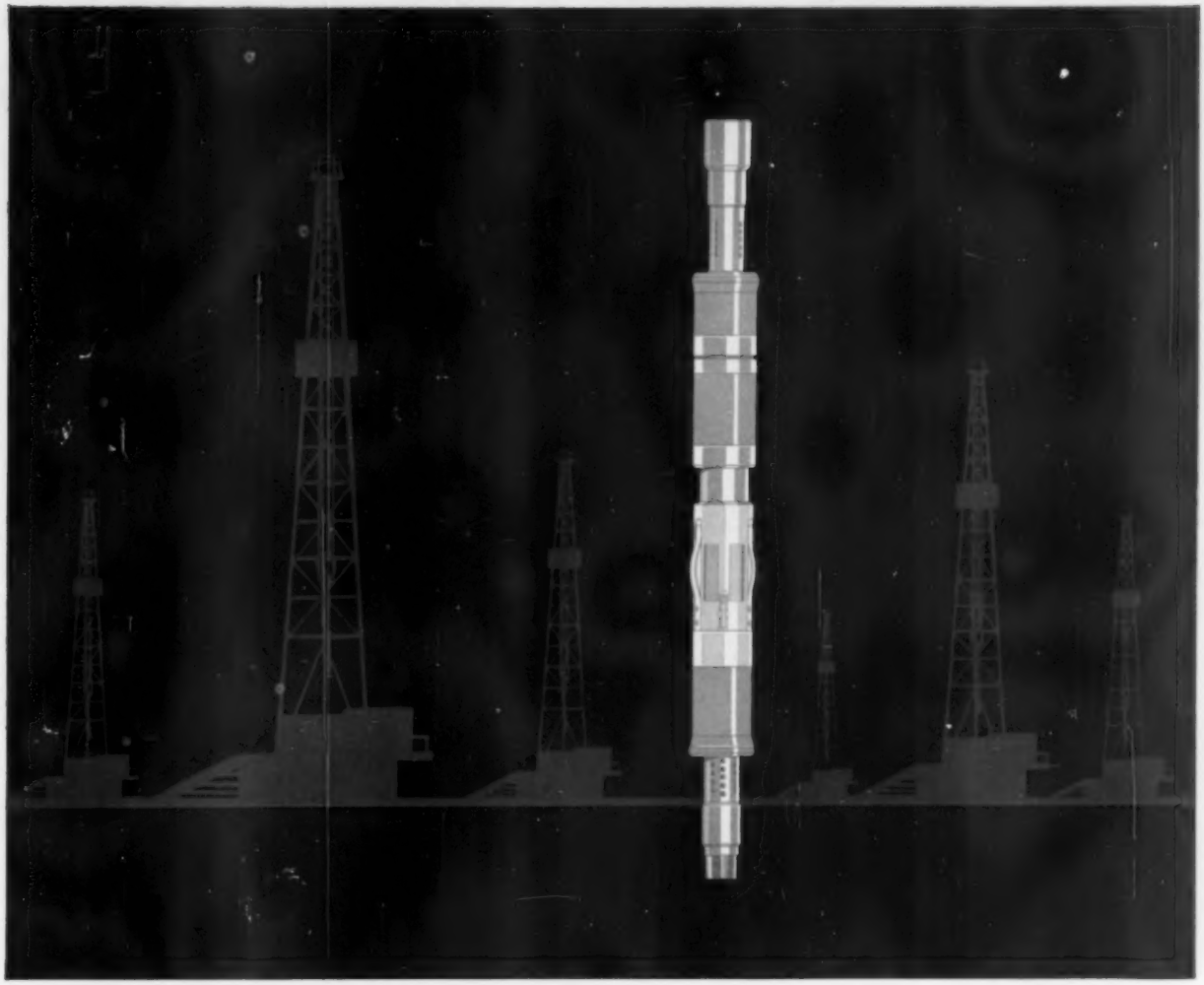
ROTARY DRILLING MACHINERY

THE WHELAND COMPANY
CHATTANOOGA, TENNESSEE, U.S.A.

DRAW WORKS • SLUSH PUMPS • ROTARIES
CROWN BLOCKS • TRAVELING BLOCKS • SWIVELS

DOMESTIC DISTRIBUTORS: INDUSTRIAL SUPPLY COMPANY, INC.—Main Office: Wichita Falls, Texas • HOUSTON OIL FIELD MATERIAL COMPANY, INC.—Main Office: Houston, Texas.

EXPORT DISTRIBUTORS: LUCEY EXPORT CORPORATION—233 Broadway, New York 7, New York—Broad Street House, London, E. C. 2, England.



BROWN DUO-PAK PACKER – KING OF THE OILFIELDS SINCE 1949

Time tested and proved best in thousands of wells, this is the all purpose packer for all producing problems. The cup seals, both above and below the primary sealing element, seal in the casing and on the mandrel and positively prevent leakage from below or above.

Large by-pass ports permit free running, and the packer is set by simply turning five turns to the right and lowering the tubing approximately five feet. A very small amount of tubing weight is required since only the cross-sectional area of the tubing is exposed to upward pressure. After setting the Duo-Pak you can apply pressure either above or below to test the casing or for squeezing, or for production stimulating measures such as acidizing and fracturing.

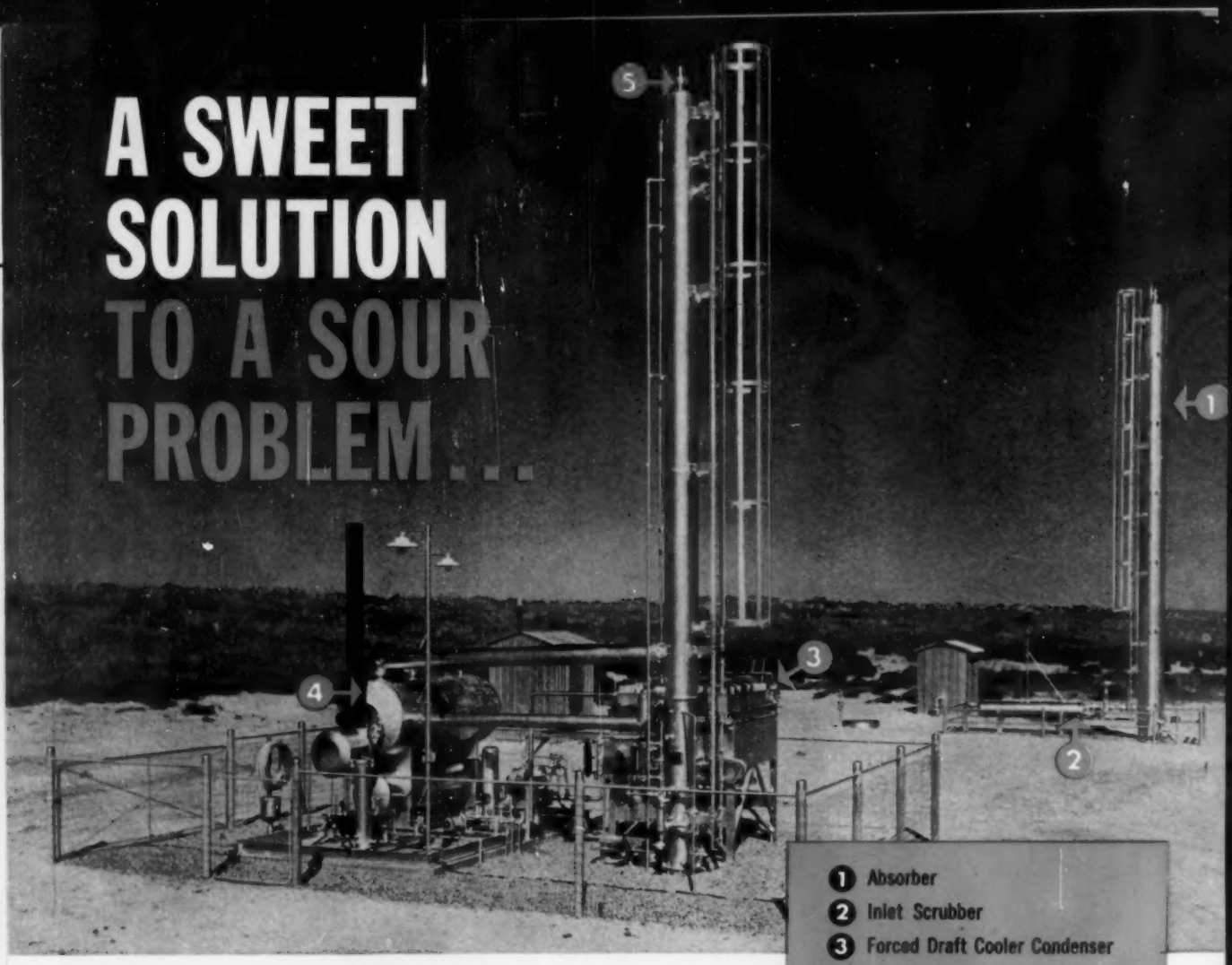
To pull the packer, no rotation is required – you simply pick up the tubing. This opens the by-pass ports and releases the slips so that the packer can be pulled or relocated.

In addition to being ideal for single and dual completions, stimulation and workover techniques, the Duo-Pak's simplicity of construction makes servicing easy and mechanical failure virtually impossible. In case of stuck pipe or other emergency, the entire packer, except the stem, is readily drillable.

For your next job, remember the Brown Duo-Pak Packer – proven in thousands of wells during the past 12 years. 1. First Packer developed where all working parts are enclosed to prevent corrosion. 2. First Retrievable Packer developed to withstand differential pressure without hydraulic hold-down. 3. First Packer for permanent type well completion – full opening – low tubing load. 4. First Packer to withstand deep swab-down test and still be retrievable.

BROWN
OIL TOOLS, INC.
8490 KATY ROAD P. O. BOX 19236,
HOUSTON 24, TEXAS

A SWEET SOLUTION TO A SOUR PROBLEM...



1. Absorber
2. Inlet Scrubber
3. Forced Draft Cooler Condenser
4. Reboiler
5. Still Column

This unit which processes 4 MMSCFD at 180 Psig. is located in the Hugoton Gas Field, and operates on a completely unattended basis.

BS&B Desulfurizers with Corrosion Control

. . . Standard for the Industry

Among gas processing people, BS&B is known for *conservative* design. What does this mean to you? . . . It means that day after day, year after year you get excellent service from your process equipment. It means the quality is built in . . . not brushed on.

Here's why BS&B has sold more desulfurizers than any other manufacturer in the industry:

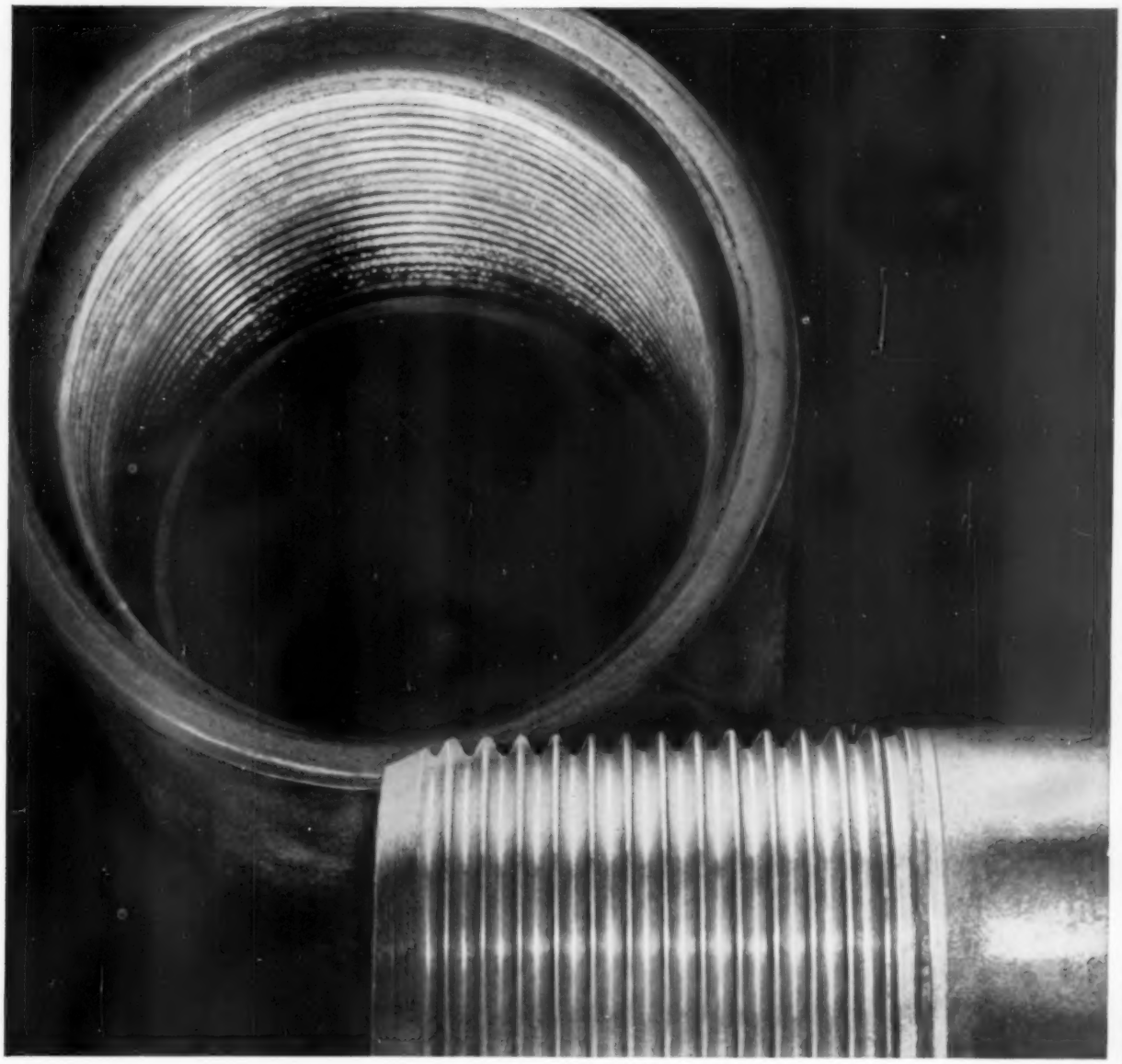
- *All vessels and welded connections fully stress relieved.*
- *Lowest practical regeneration temperatures.*
- *Control of suspended solids by filtration.*
- *Oxygen block-out from atmosphere.*
- *Low solution velocities in heat exchanger.*
- *All Amine solution returned through a reclaimer, if desirable.*

Ask your local representative or write to Black, Sivalls & Bryson, Inc., Dept. 1-GY4, P.O. Box 1714, Oklahoma City, Oklahoma.

BSB

BLACK, SIVALLS & BRYSON

OKLAHOMA CITY • EDMONTON • LONDON • PARIS • THE HAGUE



Look at the *precision threads* on CF&I Tubing and Casing

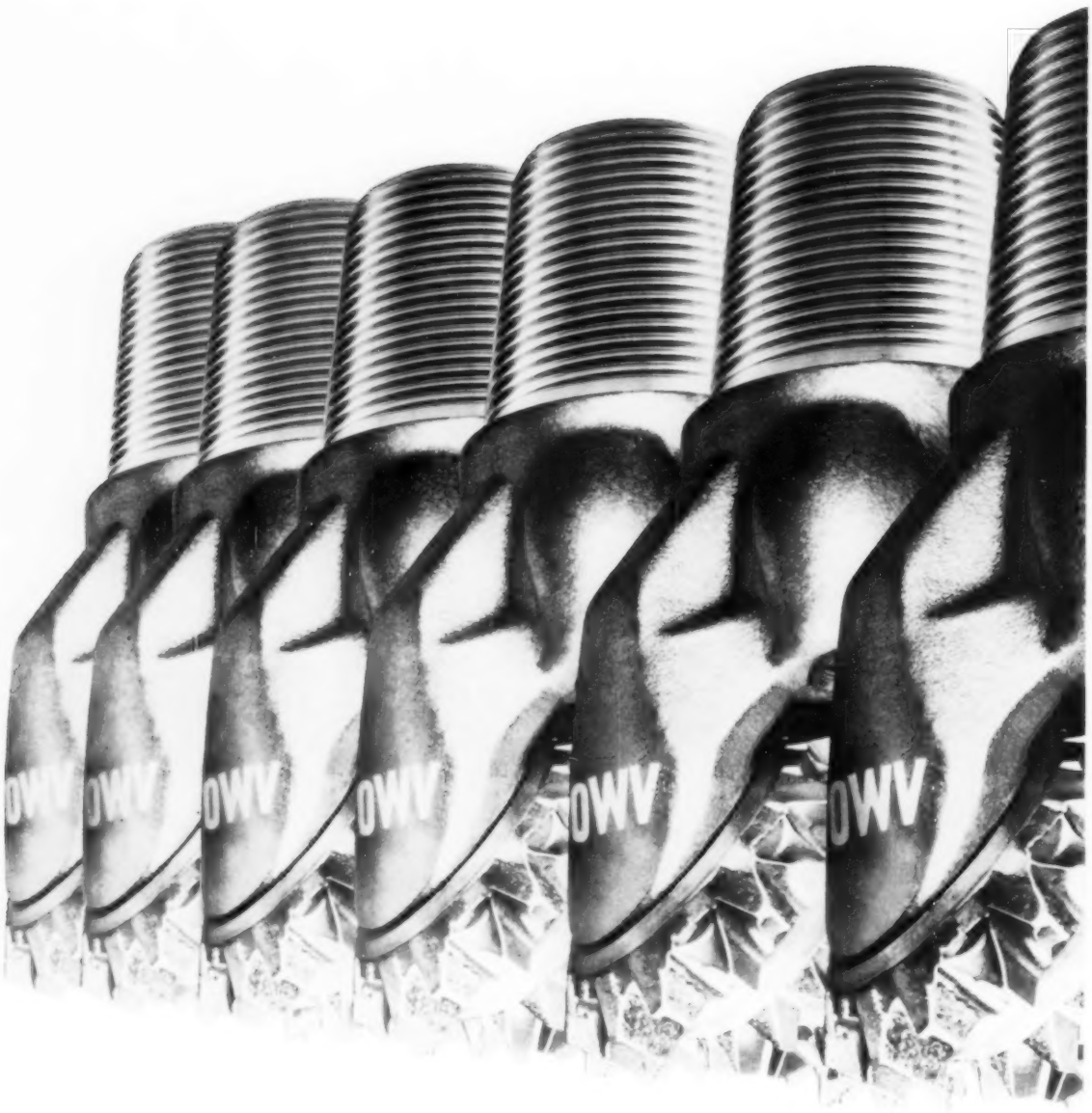
There's not a weak link in the lot. Every thread has the right lead, taper, height and size. The result is seamless tubing and casing that has *extra* strength and is pressure tight where it needs it most—at the critical area of the threaded connection.

CF&I Oil Country Casing and Tubing meet API STD 5A specification and are available in sizes from 2⅜" to 9⅝" O. D. Contact your nearby CF&I sales office or distributor for speedy delivery.

7965

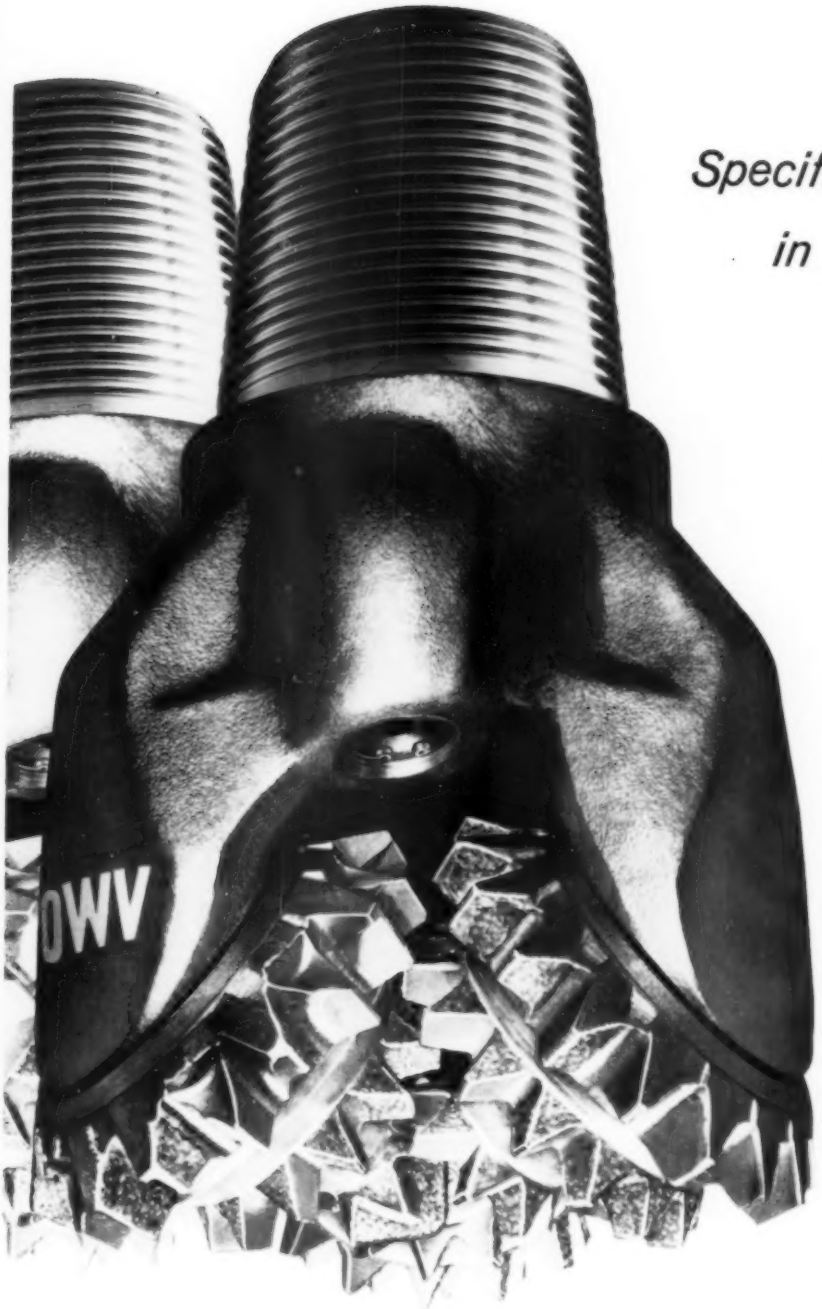
The Colorado Fuel and Iron Corporation
Denver • Oakland • New York
Sales Offices in All Key Cities

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



We don't change the name...we change

Regardless of how well a bit performs, our engineers are never satisfied. They are continually challenged by new facts from research and the field to find new ways to increase footage and penetration rate. The



Specific new improvements in the **Hughes OWV**

7 major changes in the OWV are helping to increase footage and penetration rate and lower hole costs

Change No. 1 lengthens life of bit under severe operating conditions. Bearing pin substantially strengthened.

Change No. 2 assures better bearing alignment during life of bit. Thrust bearing capacity increased.

Change No. 3 lengthens bearing life and cutting life of bit. Metallurgy of roller bearings greatly improved.

Change No. 4 protects roller race from "shirt tail" wear. This is achieved through a new hard pad design.

Change No. 5 assures a better balanced cutting structure. This results from improvement in cone design that strengthens teeth, spearpoint and gage.

Change No. 6 assures longer tooth life. Improved hardfacing provides greater resistance to wear.

Change No. 7 achieves an improved balance between bearing capacity and cutting structure that extends life of bit and permits use of heavier weights. The result: more hole per bit at lower cost!

the performance

seven recent improvements made in the already highly versatile, fast-drilling OWV have made it an even better performing bit. For the most economical hole you can drill . . . go all the way with Hughes.

HUGHES

ORIGINATOR AND WORLD'S LEADING DEVELOPER OF CONE TYPE ROCK BITS

© 1961, Hughes Tool Company

Cutter arms are opened by pump pressure. Spring pressure and "pulling up" force arms to retract into body.

New Servco Hole Opener drills like a rock bit ...opens hole up to 3 times faster!

- Enlarges hole up to twice the drilled diameter in hard or soft formation.
- Positive opening by direct pump pressure.
- Full volume circulation at all times.
- Choice of fluid flow—substantially through the pilot or entirely through cone recesses.
- Choice of cones for the most efficient cutting.
- Simple, rugged construction. A minimum of parts insures trouble-free operation.

Just a casual look at the new Servco Expandable Hole Opener tells you it's a *simple*, rugged tool, built to take a lot of hard downhole use. A closer look reveals the secret of its exceptionally fast penetration—the use of *rock bit-style* cones. In operation, the Servco Hole Opener drills like a rock bit. Actual job records show holes can be opened (up to twice the drilled diameter) three times faster than with conventional hole openers. Cementing, gravel packing... any casing clearance operation...can be completed faster and more effectively, resulting in important rig-time savings.

Call your Servco field man on your next hole opening job. He'll be glad to work with you to get the maximum results.

SERVCO
...the modern drilling tools

General Offices: 2440 Cerritos Ave., Long Beach 6, California
Canada: 6909 104th St., Edmonton, Alberta • **Venezuela:** Apartado 198, Maracaibo
France: 106 rue Lauriston, Paris 16 • **Trinidad:** P.O. Box 104, San Fernando
Mid-East: Macridge Petroleum Equipment-Supply Co., S.A.L. Beirut, Lebanon

Field Offices: Ventura, Bakersfield, Lafayette, Harvey, Casper, Oklahoma City, Houston, Odessa, Denver, Farmington, Williston, Carmi

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

a christmas tree is only as strong as its weakest seal

Rector makes the hook-up that is Sealed with Steel throughout

Rector wellhead equipment is designed to insure a leak-proof seal at all connections. Compare Rector's metal-to-metal seal features with any equipment on the market using resilient packing between casing and tubing strings. The Rector principle of reinforcing temporary organic packing with a permanent ring of steel insures a positive leak-proof completion every time. Rector's built-in welding ring coupled with an API ring gasket is easy to install, immune to corrosion inhibitors, will not flow under high pressure or temperature, will not freeze or contract under low temperature, will not burn out, and never requires maintenance or replacement.

There are no weak links in your completions, when you specify Rector equipment at your favorite supply store, or from your Rector representative.

30 YEARS MAKING THE OIL INDUSTRY SAFER

Rector

Well Equipment Co., Inc.

Making the Oil Industry Safer!

1100 North Commerce, Fort Worth, Texas Houston Plant: 2215 Commerce Street

EXPORT REPRESENTATIVES: Continental-Emsco Co., Mid-Continent Supply Co., Oilwell Division of United States Steel Corporation

PESA

MONOGRAMMED EQUIPMENT CERTIFICATE NO. 2158

Curves omitted from . . .

WATERFLOOD PREDICTION COMPARISONS

(Editor's Note: Fig. 3 and 4 were inadvertently omitted from the article, "New Method Simplifies Predicting Waterflood Performance," by H. C. Slider, p. B-68 of the February 1961 issue of THE PETROLEUM ENGINEER. These figures are presented and discussed below.)

The worth of any prediction method is based on its ability to predict performance with reasonable accuracy for an actual flood. In Fig. 3, oil production rates, water production rates, and injectivities calculated in the sample calculations of the article are plotted. Engineers familiar with field flood performance in primary depleted reservoirs will note the close similarity between the calculated performance and that experienced in actual floods. In addition to the general shape of the oil and water production rate curves, the peak oil rate equals about half the injection rate and the oil and water rates cross shortly after the peak oil production. These are typical flood results and are in fact used as rules of thumb by many engineers.

Also, note the typical variation in relative injectivity during predicted flood life. This is obtained by comparing total mobility in Column 17 of Table 1 of the article with total mobility initially. At the start of the flood, relatively little difficulty may be experienced, but as the oil rate increases, oil producing thickness increases and relative injectivity decreases. Eventually, these injection difficulties level off as a large fraction of the reservoir is flowing water. In the very late stage of the flood (not plotted) there will actually be small increases in the injectivities.

Since the actual flood was extremely out of balance on an injection basis, it was impossible to compare predicted and actual flood performance of the unit studied. However, to provide some comparison of predicted and actual performance, published total field flood results are indicated with the injection rate adjusted to a daily rate comparable to that of the unit. Actual peak oil rate came late and was low as would be expected of a flood in poor injection balance.

Since actual flood results for the example calculation did not lend themselves to an easy comparison with the predicted performance, prediction calculations were applied to another set of flood data where performance results were available. Data from the example of Prats, et al ("Prediction of Injection Rate and Production History for Multifluid Five-Spot Floods," AIME *Trans.*, 1959) were used. In making this application, a continuous permeability profile was used rather than the "bar graph" profile used by Prats. Predicted oil production results are shown in Fig. 4 together with Prats' prediction and the actual field results. It is worthy of note that a small error in gas saturation before initiation of the flood would shift the predicted curve to the left, making predicted and actual curves very similar.

This comparison is not meant to detract from the Prats method which accounts for all of the factors included in the Slider method plus the variation of sweep with time. However, the Prats method is principally applicable through digital computer programming since, as the Prats paper emphasizes, ". . . the numerical work is quite burdensome, taking about three days per case for a trained computer" (desk calculator). The Slider method calculations can probably be completed in two or three hours.

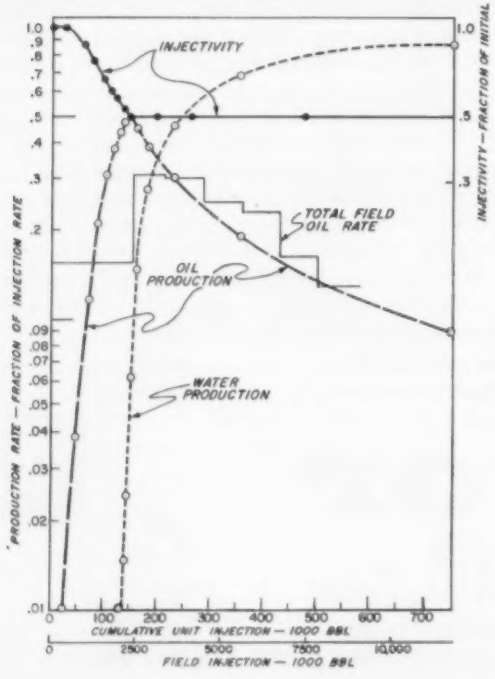
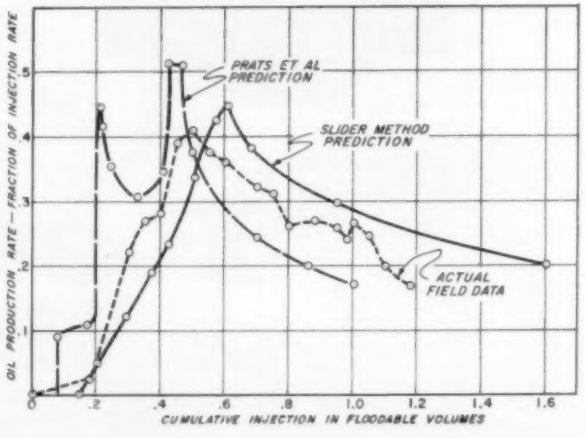

INJECTIVITY
TOTAL FIELD OIL RATE
OIL PRODUCTION
WATER PRODUCTION
PRODUCTION RATE — FRACTION OF INJECTION RATE
INJECTIVITY — FRACTION OF INITIAL
CUMULATIVE UNIT INJECTION — 1000 BBL
FIELD INJECTION — 1000 BBL

FIG. 3. Predicted performance of a flood as made with the Slider method described in this paper (The Petroleum Engineer, February 1961, p. B-68).

FIG. 4. Predictions compared with actual. Prats, et al, prediction is compared with the Slider method results and with actual field performance data.


PRATS ET AL PREDICTION
SLIDER METHOD PREDICTION
ACTUAL FIELD DATA
OIL PRODUCTION RATE — FRACTION OF INJECTION RATE
CUMULATIVE INJECTION IN FLOODABLE VOLUMES

New Drilling Detergent Saves Drilling Dollars

D-D®, Magcobar's new drilling detergent, is recommended only for operators and contractors who like money. Because, when you use D-D on your well, it's hard **not** to save money.

Look what D-D does. By reducing surface tension in water base muds, it speeds up the rate of penetration. What's more, it settles out sand, extends the use of low pH muds to greater depths, and reduces costs of chemical treatment.

Another **Well Done** with Magcobar Technology

®Registered trademark, Magnet Cove Barium Corporation.

The really big surprise about D-D is that so little does so much. Initial treatment is only ten gallons per 500 barrels of drilling fluid. Maintenance is two to six gallons per tour.

Like money? You can learn all about D-D by writing for the new brochure. Magnet Cove Barium Corp., P. O. Box 6504, Houston, Texas.

Magcobar
Complete
DRILLING MUD SERVICE

DRESSER INDUSTRIES, INC.
OIL • GAS
CHEMICAL
ELECTRONIC
INDUSTRIAL

LOOKING UP—Length of drill starts into the hole after change of bits. Falcon Seaboard Drilling Co. of Tulsa is drilling this well with a 9,500-foot string of Pittsburgh Seamless 4½-inch Grade E drill pipe. Falcon Seaboard has used Pittsburgh Steel tubular goods and an independent distributor for many years with pleasing results.

Pittsburgh Steel's Independent Distributors...

PUT THIS IN YOUR PIPE---SERVICE!

Drillers who use Pittsburgh seamless on well after well have a lot more than dependable drill pipe, casing and tubing going for them.

They have what Falcon Seaboard Drilling Co. of Tulsa calls "fair treatment from the mill" and—independent distributors who go more than the proverbial extra mile to provide service.

Boone Smiley, manager of the Mid-Continent Area for Falcon Seaboard, said:

"We've used Pittsburgh Steel's independent distributors through the years in times of short supply and when pipe was readily available. We've always felt that Pittsburgh Seamless did a job for us and the mill has always been fair."

Photographs on these pages show effective results of the close relationship between drillers and operators on one side and a Pittsburgh Steel independent distributor on the other. Here, near Maysville, Okla., Falcon Seaboard is using 9,500 feet of Pittsburgh Seamless 4½ inch O.D. Grade E Drill Pipe on the fourth well the string has drilled in the area in recent months.

The independent who supplied this drill string to Falcon Seaboard sold the first string of oil country tubular goods manufactured by Pittsburgh Steel. Continued progress through the years has been based on *service* to the trade.

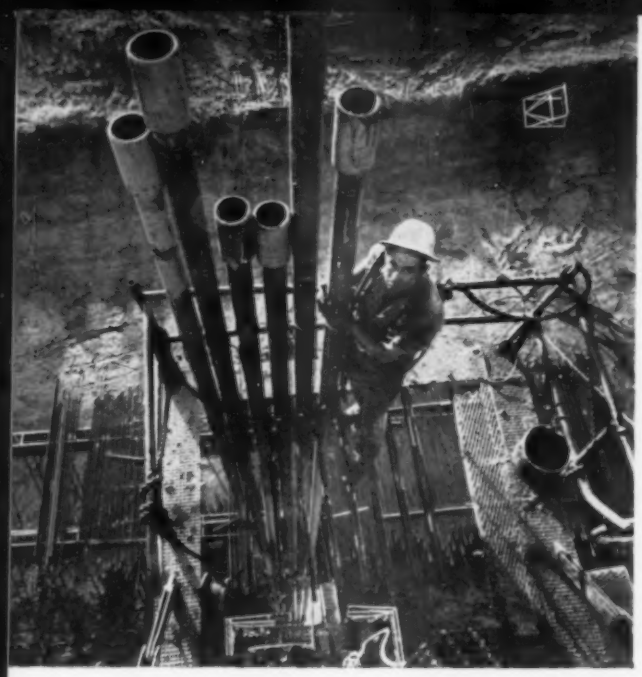
"We can't afford to get lazy," declared William G. Rudd, the distributor's sales manager. "The oil business is always subject to critical emergencies and they all have big dollar signs. It's up to us to pitch in and help."

As a case in point, during periods of acute shortage, this distributor set up a service called the Mid-Continent Pipe Exchange. As a free service to the industry, oilmen were polled for tubular material which they wished to swap for goods more strategically located, or more suited to their needs.

This extra service by Pittsburgh distributors is matched by the extra stamina you always get in Pittsburgh Seamless Drill Pipe—a stamina which stems from long experience in making special steels for the special jobs in the oil country.

When you buy your next string of drill pipe, or when you're ready to run casing or tubing, remember the combination of Pittsburgh Steel Co. and independent distributors offers you the kind of service—plus the utmost in dependable seamless tubular goods—that isn't available any other place.

It's easy to get lined up with an independent. They're listed at right. Call the nearest one today for quality seamless tubular products.



LOOKING DOWN—On monkey board of 131-foot, A-mast rig, roughneck gets joint of Pittsburgh Steel Co. drill pipe ready for re-entry during a trip. The 9,500 feet of drill pipe shown at top and on racks below was used to drill three previous wells.

Falcon Seaboard Drilling Co.'s No. 35 rig is at work here on a Sunray Mid-Continent lease near Maysville, Okla.

Driller Oliver Clark, left, chats with Max Thomas, distributor's representative, and Jewel Smith, Pittsburgh Steel field engineer.

Geolograph on same rig shows hole is at 4,296 feet with the rotary table, seen at right, operating smoothly. Geolograph chart indicates driller is midway between joint connections.

Distributor Home Offices

Atlas Bradford Company
Houston, Texas

Bennett Supply Company
Midland, Texas

Buckeye Supply Company
Zanesville, Ohio

C. W. Cotton Supply Company
Tulsa 5, Oklahoma

Franklin Supply Company
Denver 10, Colorado

Houston Oil Field Material Co.
Houston, Texas

Industrial Supply Company
Wichita Falls, Texas

Iverson Supply Company
Tulsa, Oklahoma

Longhorn Supply Co., Inc.
Houston 14, Texas

Lucey Export Corporation
New York 7, New York

Lucey Products Corporation
Tulsa 19, Oklahoma

McJunkin Corporation
Charleston 22, West Virginia

Midland Supply Company
Wichita 7, Kansas

Mountain Iron & Supply Co.
Wichita 2, Kansas

The Producers Supply & Tool Co.
Fort Worth 2, Texas

Production & Refining Equipment Company
Odessa, Texas

Sandy Supply Company
Wooster, Ohio

Southwest Supply Company
Pittsburgh, Pennsylvania

The Straker Supply Company
Jackson, Michigan

Superior Iron Works & Supply Co.
Shreveport, Louisiana

Tex-Tube, Inc.
Houston 7, Texas

Western Supply Company
Tulsa 1, Oklahoma

Pittsburgh Steel Company

Grant Building • Pittsburgh 30, Pa.

DISTRICT SALES OFFICES

Atlanta, Chicago, Cleveland, Dallas, Dayton, Detroit, Houston, Los Angeles, New York, Philadelphia, Pittsburgh, Tulsa, Warren, Ohio

Steel

AIR DRILLING FOR ABO PAY

CLARENCE S. ADAMS, *Artesia, New Mexico*

Increased use of technique in hard-rock country of Abo formation in New Mexico results after contractors obtain increased bit life and penetration rates to cut drilling time and costs. Contractors develop methods for using and maintaining special equipment needed . . . combatting formation water intrusion.

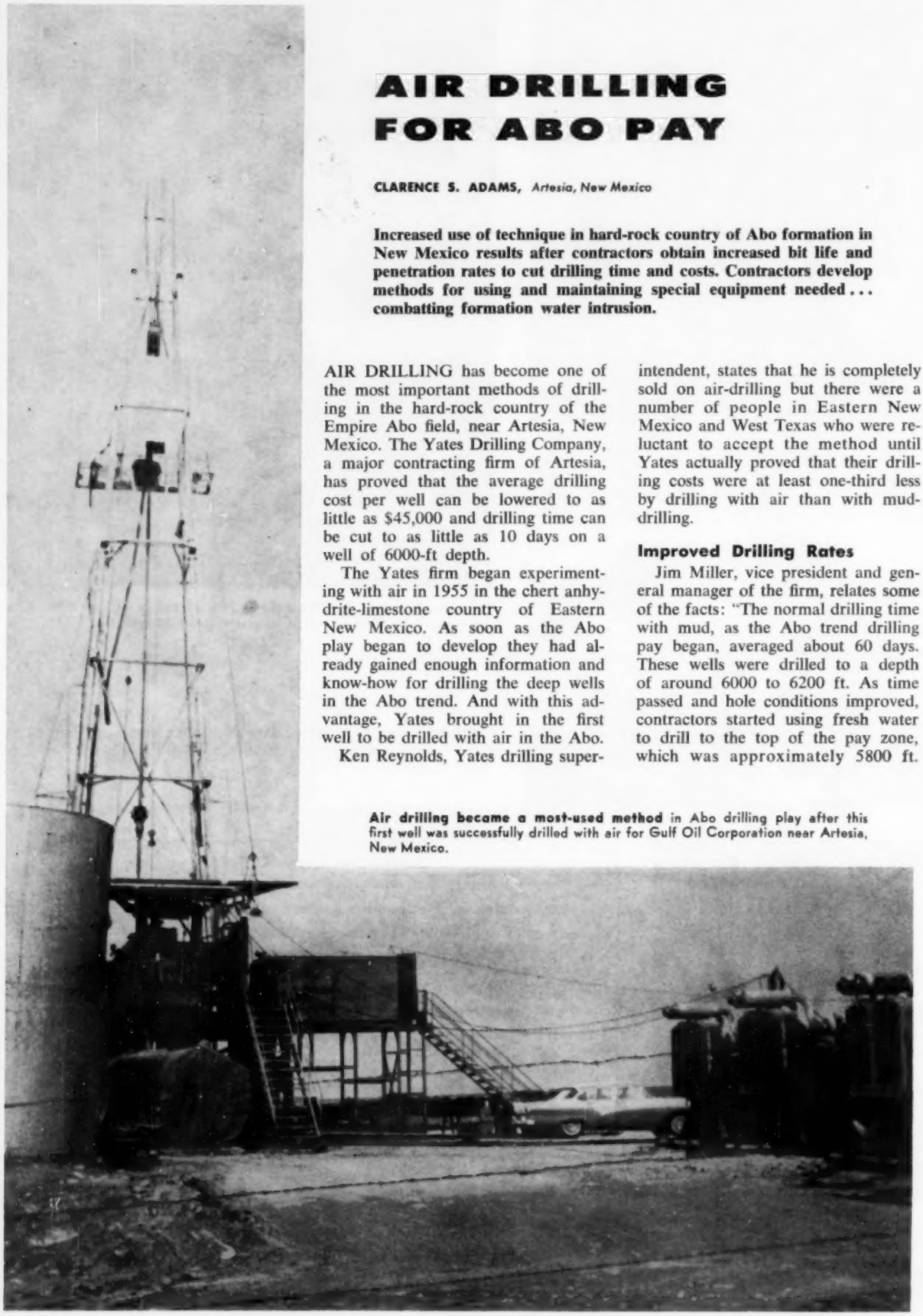
AIR DRILLING has become one of the most important methods of drilling in the hard-rock country of the Empire Abo field, near Artesia, New Mexico. The Yates Drilling Company, a major contracting firm of Artesia, has proved that the average drilling cost per well can be lowered to as little as $45,000 and drilling time can be cut to as little as 10 days on a well of 6000-ft depth.

The Yates firm began experimenting with air in 1955 in the chert anhydrite-limestone country of Eastern New Mexico. As soon as the Abo play began to develop they had already gained enough information and know-how for drilling the deep wells in the Abo trend. And with this advantage, Yates brought in the first well to be drilled with air in the Abo.

Ken Reynolds, Yates drilling superintendent, states that he is completely sold on air-drilling but there were a number of people in Eastern New Mexico and West Texas who were reluctant to accept the method until Yates actually proved that their drilling costs were at least one-third less by drilling with air than with mud-drilling.

Improved Drilling Rates

Jim Miller, vice president and general manager of the firm, relates some of the facts: "The normal drilling time with mud, as the Abo trend drilling pay began, averaged about 60 days. These wells were drilled to a depth of around 6000 to 6200 ft. As time passed and hole conditions improved, contractors started using fresh water to drill to the top of the pay zone, which was approximately 5800 ft.



Air drilling became a most-used method in Abo drilling play after this first well was successfully drilled with air for Gulf Oil Corporation near Artesia, New Mexico.

SPECIAL REPORT TO MANAGEMENT

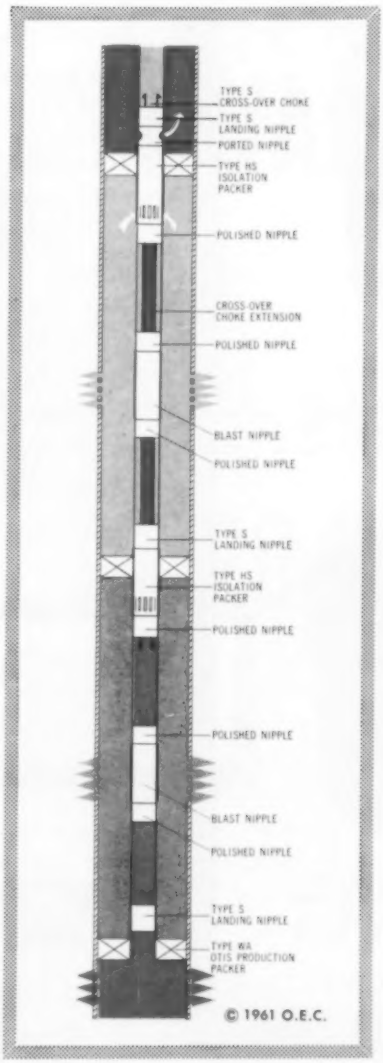
OTIS PRODUCTION NEWS

Volume II, Number 4 **Otis Engineering Corporation • Dallas** *Production Equipment and Services*

Otis Triple Zone Selective Cross-Over Completion Designed to Permit Production of Any Two Zones—Postpone Remedial Work

CORPUS CHRISTI—Operators in this area have found a new Otis Selective Cross-Over Completion ideal for producing new triple zone wells. The completion offers its greatest savings through selectivity of production, and is designed to postpone remedial operations which would entail moving a rig back over the hole. The completion is also designed to be made in standard 5½" casing using 2⅜" tubing to aid in holding downhole equipment costs to a minimum. This new Otis triple zone completion is designed to permit any one of the three zones to be produced individually with the other two blanked off, or two of the three zones to be produced simultaneously, directing the production from either zone through the annulus or the tubing as desired. When producing two of the zones simultaneously, one of the zones must be crossed-over just above the top packer through the use of a standard Otis Concentric Cross-Over Choke.

In addition to the above, this type of cross-over completion offers several other production advantages. The completion technique employed on initial installation is designed to permit each packer to be tested to the breakdown pressure of the zones before the next packer is set. Access to the upper zones is through the ports in the Sliding Side-Door® assembly of the Type HS Otis Retrievable Isolation Packer. Type HS Packers are used to isolate the upper two zones as shown in the accompanying installation diagram. In this installation, by straddling the upper zone with the top two packers, a short extension to the Otis Straight Flow or Cross-Over Choke acts to permit selective production of the middle and lower zones or the middle and upper zones through the tubing or annulus, with the alternate zone blanked off in each case. This also serves to permit chokes to be changed by standard wire line methods without requiring a rig over the hole.



In addition to these advantages, the completion technique is designed to permit any one of the zones to be exposed to the tubing or the casing, or both, with the other two zones blanked off for circulating, treating, and testing. Fracturing treatments on individual zones at pressures up to 4,500 p.s.i. have been performed in wells using this type of completion.

This is another Otis-engineered completion designed to provide the ultimate in economical, versatile, and efficient alternate-zone selective production. For more information on alternate-zone, selective and multiple completions, or for help with any other specific completion problem, call the Otis office nearest you or write Otis, Dept. 4-W, P.O. Box 35206, Dallas 35, Texas. You'll find your Otis Well Completion Specialists ready to help you . . . anxious to serve you.

OTIS

Engineering Corporation

General Offices:

6612 Denton Drive • Dallas, Texas

IT'S THE PROTECTION THAT COUNTS WITH A TOOL JOINT COMPOUND

No-Gall contains more than 50% pure metallic zinc, for those who prefer a zinc base compound. It is used on the longest strings with complete safety. SIZES AND WEIGHTS: 2½ gal. 38 lbs.; 5 gal. 75 lbs.; 15 gal. 225 lbs.

Lo-Tork has a finely screened metallic lead base. It has a low coefficient of friction and highest fluidity consistent with body required. SIZES AND WEIGHTS: 2½ gal. 38 lbs.; 5 gal. 75 lbs.

When ordering a tool joint compound, remember it's protection for the threads that you are buying. And for this purpose WECO No-Gall or Lo-Tork are the finest compounds you can use.

They spread completely around the threads but will not harden or squeeze out under high pressure or temperature. They remain soft in the can at all temperatures and in all weather for easy application. Finely screened pure metallic zinc or lead is dispersed in a neutral oil with a tacky additive to give you the kind of thread protection you need. WECO Compounds never require thinners and are not affected by extremes of hot or cold weather.

Dope your string right . . . with a WECO Compound. Available from supply stores everywhere.

Also ask your supply store for WECO Hi-Speed Seal; WECO Steel-Aid and WECO-API Hi-Pressure thread compound to be sure of leakproof connections and positive thread protection for all oil field threaded connections.

WECO

WELL EQUIPMENT MFG. CORP.
HOUSTON, TEXAS
Division of CHIKSAN COMPANY a subsidiary of FOOD MACHINERY AND CHEMICAL CORPORATION

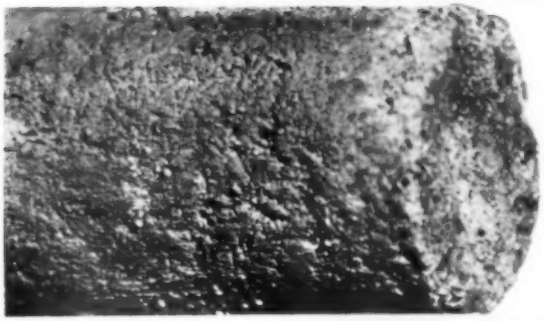
C-1-61

fmc

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

NEW SCHLUMBERGER BULLET DESIGN

EXTENDS SIDEWALL CORING



TO 20,000 FEET!

A new improvement in bullet design has made practical — for the first time — sidewall coring at 20,000 feet.

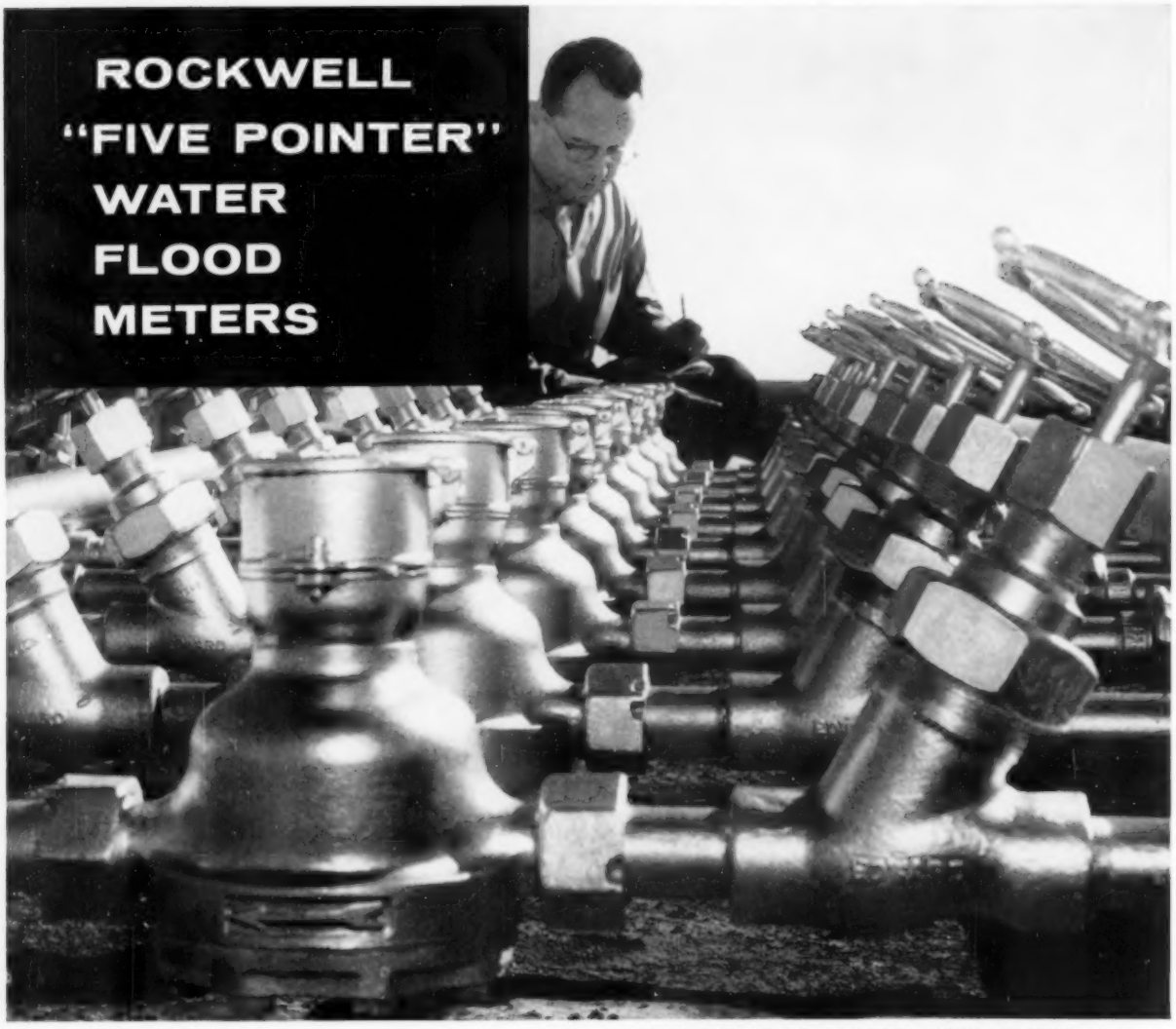
At all depths the new bullet has provided cleaner, less altered cores to enable better laboratory analysis. Improved percentage of recovery has reduced the number of runs required and, thus, has reduced rig time.

This is another example of the persistent efforts of Schlumberger engineering. Tools and Services, both new and old, are constantly improved to do an even better job for the oil operator.

SCHLUMBERGER

THE EYES OF THE OIL INDUSTRY*

ROCKWELL "FIVE POINTER" WATER FLOOD METERS



Rockwell 504 "Five Pointer" meters with Edward throttle valves.

Give you positive, dependable control over secondary recovery

This pictured installation offers you many advantages for measuring and controlling the water injection method of secondary recovery.

The meters are bronze case Rockwell "504's." They are especially designed to operate at today's higher flooding pressures. Interior meter parts of either bronze or nickel alloy are optional depending on an analysis of the water. Meter register has sweep hand with dial reading 1/10th barrel per revolution to permit you to time input rates quickly and accurately.

Valves by Edward (a Rockwell subsidiary) are noted for their precise control and ease of operation.

For complete details and specifications write Rockwell Manufacturing Company, Dept. 123D, Pittsburgh 8, Pa. In Canada: Rockwell Manufacturing Co. of Canada, Ltd., Box 420, Guelph, Ontario.

Get this "Reddi-Rate" Setting Table FREE to assist you in calculating waterflooding flow rates with Rockwell's 504—5-Pointer Meters.

Rockwell Manufacturing Company
Dept. 123D, Pittsburgh 8, Pa.

Please send me a wallet size, "Reddi-Rate" plastic card without obligation.

Your Name _____

Company _____

Street _____

City or Town _____ Zone ____ State ____

WATER FLOODING METERS & VALVES

another fine product by

ROCKWELL

This equipment layout was used recently to air drill Continental State S-30 No. 1, now an oil producing well. Yates places two smaller compressors between two larger ones, all hook into an 8⅝-in. manifold. Water tank feeds into soap pit.

Preparations to inject soap into air supply line are discussed by L. K. Smith, Yates drilling foreman, right, and a maintenance crewman.

Then they would mud up to drill the pay zone and complete the well, which of necessity, decreased penetration rates considerably.

"When we began to use the air-drilling method it took about 20 days. We kept on improving drilling techniques until now we have the average time down to about 12 days."

L. K. (Bubba) Smith, Yates drilling foreman and a top driller, points out that they drilled one well, Hondo-Western-Yates State A-22 to a depth of 6350 ft in a record time of 8½ drilling days and used six bits in 11 days overall to total depth. Smith also states that they once drilled 145 ft into Abo pool with air before they picked up enough fluid to "load up." He states that once fluid is encountered, loading up will begin and will continue until air-circulation will stop. However, on that well, enough gas was encountered to help maintain air circulation and kept loading up from occurring.

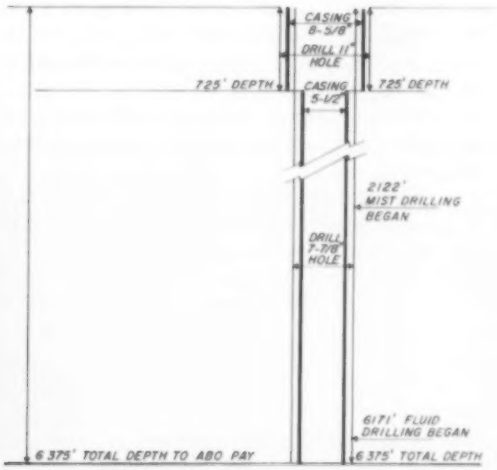
In comparison, Yates Petroleum Company-Len Meyer No. 1, which was drilled by Yates Drilling Company, was drilled with air from 1255 ft to a depth of 5931 ft. Here they turned to mud-drilling for 3294 ft to a total depth of 9225 ft. When they turned to mud the average penetration rate dropped considerably to 14 ft per hr. It took 34 bits and 46 days to complete this well. However, 10 days of that time were spent in coring.

As was previously stated, due to water encroachment, the last 204 ft of Continental State S-30 No. 1 was drilled on fluid. The usual procedure is to drill as far as possible with air until "loading up" begins, then finish the well with fluid. However, the first well that was drilled with air in the Abo, Yates drilled entirely from spud to pay with air. Sometimes they are fortunate in staying in dry formations for several hundred feet. There is also the slight possibility of picking up enough gas at times to take care of any "loading up" that may occur. However, this is a rare occurrence.

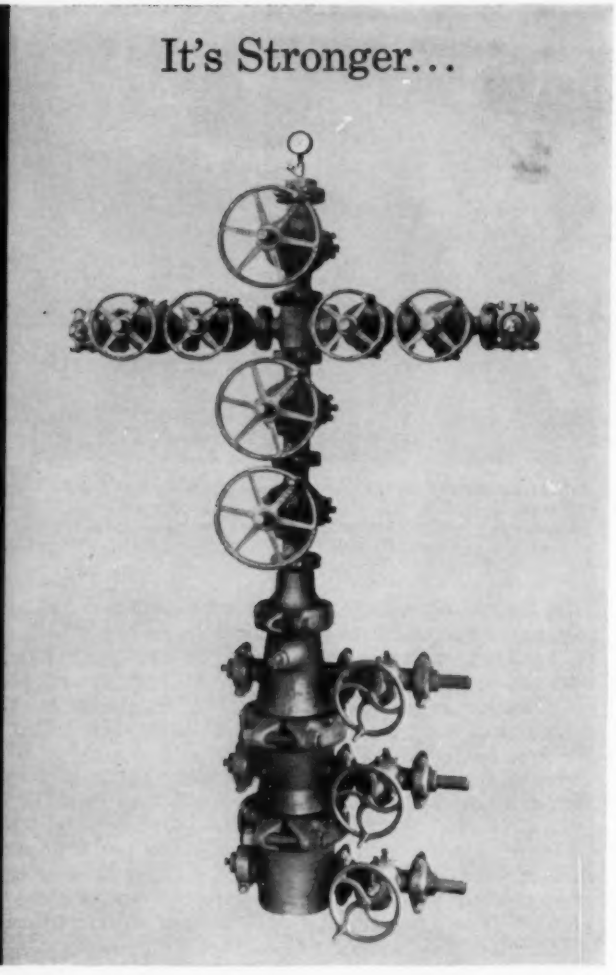
So far, Yates' best penetration rate record from spud-in to the total depth (6350 ft) was an average of more than 34 ft per hour. This was on Hondo-Western-Yates State A-22 and was drilled in a record time of 8½ days with two conventional bits and four chert-type air bits. The best single bit run was accomplished on Hondo-Western-Yates State A-11. Here they penetrated 2252 ft in a 72 hr period.

Smith feels there is a possibility that penetration can exceed 90 ft per hr in the top dry formations such as the anhydrite beds above the San

Blooie line spews particles into reserve mud pit during mist drilling on well.



Typical drilling and casing program used in Empire Abo field.



It's Better BECAUSE OF GRAYLOC

A Gray Well Head assembly, with GRAYLOC® connections, weighs about 26% less than a comparable flanged hook-up, yet it withstands an equal pressure. With only two bolts per connection, it's easier and quicker to nipple-up than flanged units and the assembled unit is about ⅓ smaller.

You save labor, space and time while getting the utmost blow-out protection and the longest possible stretch for your production dollar.

Why not let Gray assemblies help you bring your cost down? A great many of our customers have. Just ask your Gray representative or write today for more details.

	Flanged Assembly	GRAYLOC Assembly
Test Pressure	15,000	15,000
Height	136"	111"
Center to center of Flow Wings	95"	86"
Weight	6,591#	4,878#

GRAY *Tool Company*

6102 P. O. BOX 2291 HOUSTON 1, TEXAS RIVERSIDE 7-1240

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

soltex*

A NEW AND REVOLUTIONARY "FIELD-PROVEN" DRILLING MUD ADDITIVE!

From the developers of Driscose, the original CMC, now comes SOLTEX! A black, free flowing, flake material . . . SOLTEX is a modified, high molecular weight hydrocarbon compound that is soluble in both oil and water. It offers all these outstanding benefits:*

Stabilizes Shale Sections—The addition of SOLTEX has already corrected or prevented shale troubles in many wells. One Louisiana offshore well had drilled into salt and two attempts to deviate the hole with whipstocks failed because of sloughing shale and thick wall cake. After adding 5 lbs./bbl. of SOLTEX to the system, no further hole trouble was encountered and a 30° deviated hole was successfully drilled from the third whipstock to final T.D. In addition to controlling shale, the torque and drag of the drill pipe was reduced.

The Anahuac Shale in the Texas Gulf Coast area is noted for causing trouble. Recently, on a well drilled near Hitchcock, Texas, the usual difficulties expected from "shale balling" were avoided by adding 5 lbs./bbl. of SOLTEX to the mud before drilling into this shale section. The well was completed without incident.

Inhibits Dispersion of Drilled Solids—Laboratory data and field experience show that the effects of solids build-up of muds containing SOLTEX is lower than for other types of muds. Even muds with inhibited filtrates are improved. This results in less jetting and reduces the need for chemical treatment which makes possible more savings.

SOLTEX Protects Against Clay Solids

	Concentration lb./bbl.	Total Bentonite Added, lb./bbl. 0	20	30
		(Plastic Viscosity/Yield Value)		
Base Mud—	0	2/0	13/9	41/62
SOLTEX—	10	3/0	9/4	17/16

Replaces Oil In Many Muds—Geologists are sometimes handicapped by staining and fluorescing caused by oil in the mud. Replacing oil with SOLTEX in such muds provides a dull yellow fluorescent background for an easily recognized reference.

The use of SOLTEX as a replacement for oil also provides other benefits. For example, in the Alta Loma Field, Galveston County, Texas, wells drilled to a T.D. of 12,000' normally use from $3,000 to $6,000 worth of diesel oil. On one such well drilled in this field, $5,678 worth of SOLTEX was used to replace oil. This offset the cost of diesel oil *plus* an additional $2,000 to $4,000 worth of shale control material that ordinarily would have been used. Also, indirect savings resulted from better control of fluid loss and flow properties.

Increases High Temperature Resistance—In most drilling muds, extreme high temperatures create problems in controlling viscosity, gel, and water loss. SOLTEX mud systems allow more exact, trouble-free control of these properties at high temperatures and pressures.

SOLTEX in High Temperature Mud

Concentration lb./bbl.	Initial AV (a)	Initial WL (b)	10 Hrs at 300°F AV	10 Hrs at 300°F WL	10 Hrs at 300°F Bos (c)	300°F—500 psi Test WL	300°F—500 psi Test Cake
0	37	8.4	44	10.2	700	19.6	5/8
4	39	6.4	35.5	6.6	NM	NM	NM
6	37.5	5.6	35.5	6.0	350	10.9	1/4
8	37.5	6.0	35	5.2	NM	9.0	3/16

(a) Apparent Viscosity (b) Water Loss (c) Boshears-Unit Measure of high temperature gelation. NM—Not Measured.

Multiple Benefits Reduce Drilling Costs—The examples above indicate only a few of the many benefits you can expect from versatile SOLTEX. Results from numerous test wells show that SOLTEX complements the effectiveness of Driscose to extend water loss control, to toughen and reduce filter cake, reduce torque on the drill pipe, improve lubrication of the drill bit, and emulsify oil. Because of these multiple benefits, *SOLTEX can reduce your drilling costs!* Field-proven performance has clearly established SOLTEX as . . . "one of the most important mud discoveries since Driscose, the original CMC material".

For more complete information on amazing new SOLTEX—see your Drilling Specialties Company Representative . . . or contact your mud dealer.

DRILLING SPECIALTIES COMPANY
Bartlesville, Oklahoma

*Soltex and Driscose are trademarks

Look at It

...each way you save with MISSION PISTONS

Every minute that it's working, the Mission Piston is working for you. Working to cut your pumping costs, working to cut your downtime. Here's why: These bodies are lightweight, one-piece *forgings;* yet they're strong enough to resist extremely high pump pressures. The special fabric backing of the rubber compounds provides just the right degree of reinforcement for maximum piston rubber life.

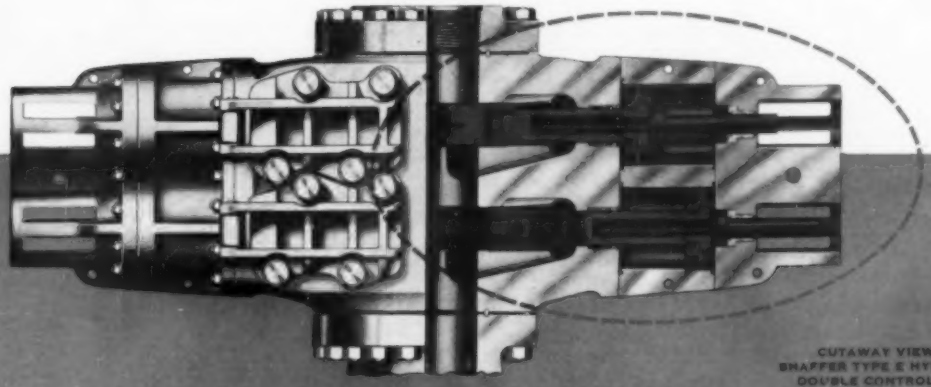
The three long-life piston rubber compounds available are designed for your specific drilling operations to save you the most. Plus, these rubbers are replaceable, saving about half the cost. And you can replace them without removing the piston, saving even more. Mission pistons are the standard, because of Mission engineering, Mission quality control, and the Mission guarantee.

MISSION MANUFACTURING CO. P. O. Box 4209, Houston, Texas • Cable Address 'MISSCO' Export Office: 30 Rockefeller Plaza, New York • In the United Kingdom: MISSION MANUFACTURING CO., LTD., 1 Hanover Square, London W. 1 England • cable address 'MISSOMAN'

MISSION MANUFACTURING CO

WHEN YOU BUY BLOWOUT PREVENTERS

GET SHAFFER "IN-LINE" POWER DRIVE ...IT'S POSITIVE!



CUTAWAY VIEW OF SHAFFER TYPE E HYDRAULIC DOUBLE CONTROL GATE SHOWING "IN-LINE" POWER DRIVES

WHAT IT IS... In Shaffer Blowout Preventers there is no complicated system of levers, rods and linkages connecting the rams with the hydraulic pistons that operate them.

Instead, each Shaffer ram and its operating piston is on a *single* stainless steel shaft that is fully enclosed within the body of the Preventer. When the piston moves the ram moves. There are no complex connections to jam, freeze or otherwise jeopardize positive action!

WHY IT'S BETTER... By eliminating levers that rock, connections that rotate and exposed linkages that move, you eliminate potential trouble spots that can interfere with quick, *positive* action when emergencies threaten.

- Shaffer Preventers give you the simplest, most trouble-free ram and piston design it is possible to build—with both the ram and its operating piston on a *single* shaft—and no complicated connections in between!
- Pressure seals are also reduced to a minimum because far fewer seals are required. And any time you eliminate seals you reduce maintenance, as well as possible problems, when high well pressures are encountered.
- Shaffer's design also means elimination of connections that require frequent oiling or greasing... elimination of exposed operating parts that can become corroded by chemical-laden muds or well-treating fluids... elimination of levers or yokes that can become jammed by loose boards, pieces of pipe, or other objects falling from the rig floor.

RESULT... When pressure emergencies threaten the safety of your well, Shaffer Blowout Preventers provide unequalled assurance of *positive* ram operation... and this is just one of the many "plus" advantages built into *every* Shaffer Blowout Preventer!*

THERE'S A SHAFFER BLOWOUT PREVENTER FOR YOUR PARTICULAR REQUIREMENT!

TYPE B and TYPE E Preventers are the units selected for most drilling applications. Type B has *non-rising* Locking Shafts for maximum compactness... Type E has *rising* Locking Shafts for quick ram indication.

TYPE XHP Preventers are ideal where extra-high well pressures are a problem. Each XHP unit is individually tested to 15,000 PSI *Working* Pressure in 7 1/16" Bore Size... to 10,000 PSI *Working* Pressure in 9" and 11" Bore Sizes.

TYPE LWS Preventers combine lightweight with adequate pressure rating for a wide range of applications. LWS units weigh approximately *half* as much as other Preventers of comparable size.

The above Preventers (except Type XHP) are available in choice of *Double* units (*two* Preventers unitized into one compact body for maximum space-saving)—or *Single* units.

See your nearest Shaffer representative for complete details. Or write direct!

*OTHER SALIENT SHAFFER ADVANTAGES...

- "Swing-Open" Doors for Quick Ram Changes!
- Space-Saving Compactness!
- Self-Cleaning Ram Compartments!
- Completely Enclosed Construction!
- "Floating" Ram Design!

...and still others your Shaffer representative will gladly explain to you!

38 years OF OIL TOOL LEADERSHIP

SHAFFER

HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT - FISHING TOOLS THAT EXCEL

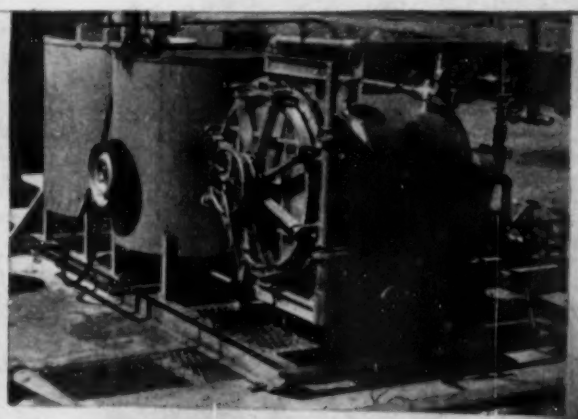
CALIFORNIA SERVICE SHOPS: Santa Fe Springs, Santa Maria, Ventura, Avenal, Bakersfield and Taft
HOUSTON, TEXAS, 6006 Navigation Blvd. • ODESSA, TEXAS, 1925 West Second Street
OKLAHOMA CITY, OKLAHOMA, Shaffer Tool Works, 6201 South Shields Boulevard
FARMINGTON, NEW MEXICO, Shaffer Tool Works, Post Office Box 546
CASPER, WYOMING, Shaffer Tool Works, Post Office Box 1788
HOUMA, LOUISIANA, Shaffer Tool Works, Post Office Box 827
EXPORT SALES OFFICE: Shaffer Tool Works, 500 Fifth Avenue, New York, N.Y., U.S.A.
IN CANADA: Shaffer Western Hemisphere, Inc., 5823 103A Street, Edmonton, Alberta.

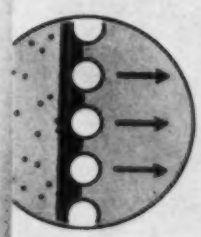
Inject water faster, keep back-pressure low with Celite Portable Filtration

Don't use inefficient, over-sized filter units to handle injection water. Now you can get fast, clean repressurizing water flow with a portable Celite® filtering system that is one-tenth the size of old-fashioned units with the same capacity. This compact unit can be mounted on skids for quick, easy installation and relocation.

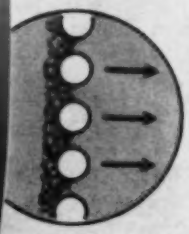
Celite diatomite filter aids remove oil, amoebae, algae and bacteria from injection water. By eliminating pore-clogging suspended solids, pumping pressure and costs are kept low and oil recovery kept high. Data from a 10,000-barrel-a-day installation show that Celite, as compared to sand, reduced hold-up time from four hours to only 30 minutes. What's more, additional reports show backwash water requirements can be reduced up to 90%.

A complete line of standard and special Celite grades is available to meet every need. For full details on how Celite assures the best quality filtration at the lowest cost, send for Technical Bulletin FF-78. Write Johns-Manville, Box 14, New York 16, N. Y.

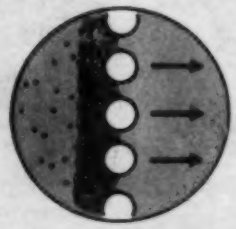




WITHOUT CELITE, fine suspended solids form a clogging seal over filter openings.



WITH CELITE, a porous cake with microscopic channels becomes the real filter surface.

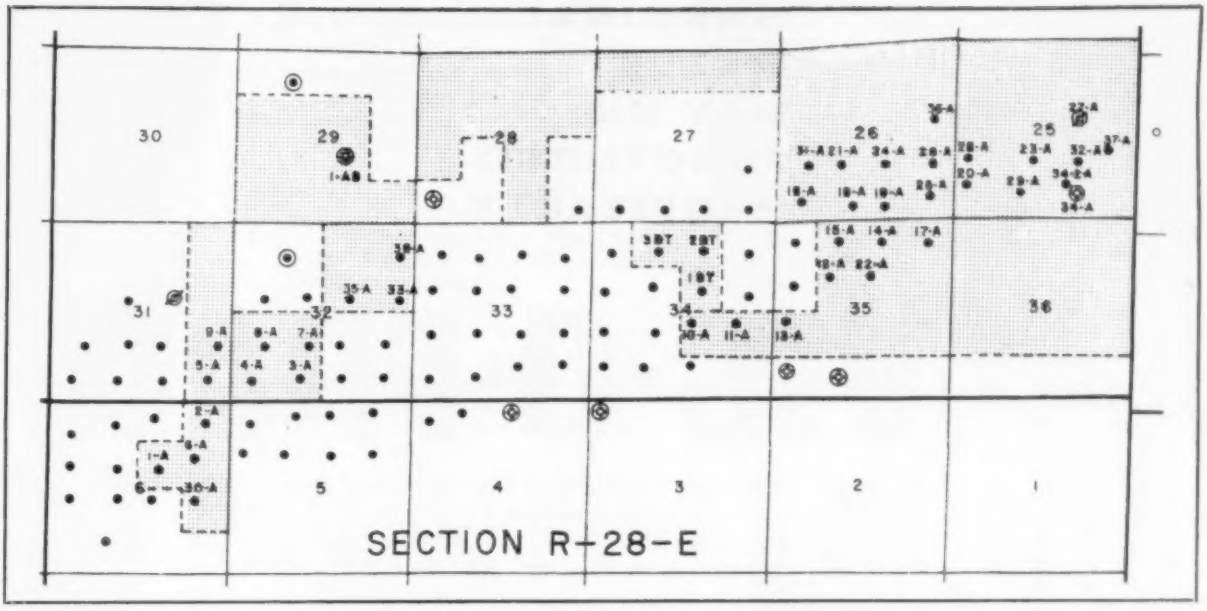


DURING FILTRATION, continuous bodyfeed of Celite builds up fresh filter surfaces, greatly extending cycle life.

JOHNS-MANVILLE

JM

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



Acceptance of technique in particular section of Empire Abo field shows wells Yates has air-drilled, indicated by shaded areas.

Andres limestone. However, bit bearings cannot stand the weight of 65,000 to 75,000 lb and the 70 to 80 rpm necessary to exceed this rate of penetration in air-drilling. So he maintains about 45,000 lb of weight and 45 rpm with his medium-depth rig.

Air Drilling Wide-Spread

Since Yates helped to develop the Abo play with air-drilling and proved its economical value, it has become fairly routine throughout the Empire Abo field. Other drilling contractors have adopted the idea and have equipped their rigs to handle air equipment which is procurred on a rental basis throughout the area.

Not all the air-drilling is done in deep Abo wells, however. Recently a number of shallow well contractors have adopted the idea. Western Development-Harvey Yates State 169 was brought in with pay early in January this year at a depth of 2200 ft, and it was drilled entirely with air. Therefore, it seems there is a definite trend toward air-drilling over all the hard-rock country of Eastern New Mexico.

A. J. Deans of Hondo Oil and Gas Corporation also is a firm believer of the Yates method. He says that the Yates firm is actually a pioneer in the field of air-drilling and they deserve major credit for improving the method and making it work along the Abo.

Results Obtained

In their many experiments, Yates found that the use of air instead of mud through a dry-penetrated section results in increased bit life as well as increased penetration rates. The use of air allows a continuous, reliable evaluation of the penetrated section, and has been recommended as a possible circulating medium when low reservoir pressures are anticipated.

They have also discovered that quite often, pockets of oil may be discovered at shallow depths which might have otherwise been by-passed if mud had been used for drilling.

Yates has experienced little difficulty with deviation on any of their air-drilled wells. Smith checked for deviation on Continental State S-30 No. 1 at 4552 ft and found there was a deviation of 1¼ deg. Later he checked at a depth of 4867 ft and found the deviation had moved to 1½ deg. When the well was completed the deviation was less than one degree.

Air Drilling Program

The routine program for air-drilling in the Abo now is to drill an 11-in. hole to a depth of about 750 ft. Then an 8⅝-in. casing is run. Usually one or two conventional-type bits with 5/16-in. jets are used to a depth of about 2100 ft. Then the special type chert bits, designed for air-drilling, are used. Since jets would give a high pressure drop through the nozzles, necessitating a loss of air volume, all jets are taken out of the bits. It usually takes from 9 to 11 of these to complete a well, although 45,000 lb of weight is kept on the bits at 45 rpm.

A 4½ in. drill pipe is used, drilling a 7⅞-in. hole which is usually cased with 5½-in. casing, although some operators prefer 4½-in. casing.

Using Compressors

Yates obtains a capacity of about 1150 cfm with their large compressors, and about 450 cfm with the smaller compressors at 300 psi. Since the altitude along the Abo trend is approximately 3300 ft above sea level to begin with, the capacity is reduced somewhat to that of compressor capacity at sea level.

On the Continental State S-30 No. 1, a well which was brought in by Yates Drilling Company on January 12, 1961, they found that by varying the number and type of compressors at the location they could attain a wider flexibility in the rate of air circulation. Therefore, they kept two large compressors and two small compressors at the well, although only one of the large compressors was used most of the time with two of the smaller ones. With this set-up they can maintain a steady air input rate of at least 2000 cfm in a 7⅞-in. hole at a 6000-ft depth.

Operating pressure depends largely upon water encroachment. However, Yates drillers try to maintain a pressure of around 150 psi in dry drilling to about 300 psi in "mist" at the 4000 to 6000 ft depth, getting a maximum velocity of returns of about 3000 ft per minute in dry formations to around 2000 ft per min in wet formations.

Guy Williams, Yates driller on Continental State S-30 No. 1 says he has compressor power to go to 500 psi standpipe pressure if he needs it, although he usually holds it at about

MARGINAL WELLS MAY BE FRACTURED PROFITABLY

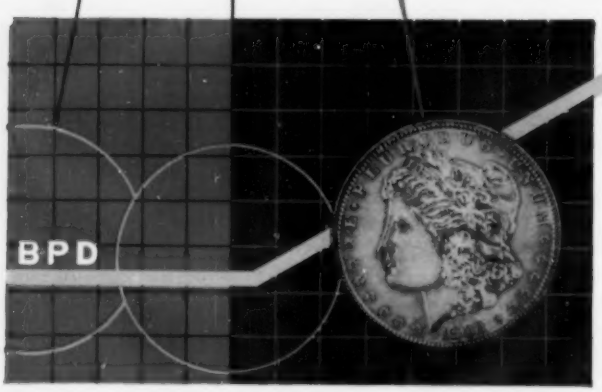
...with

VIS-O-FRAC

The profit pendulum of a marginal well often swings to the plus side following a Halliburton VIS-O-FRAC treatment. VIS-O-FRAC is designed for maximum economy from the word *go!* Check these benefits:

- **LEASE CRUDE** or other available light hydrocarbons may be used.
- **LOW FRICTION LOSS** to help reduce surface horsepower requirements.
- **LOW FLUID LOSS** to cut waste — retains more fluid *in the fracture* for improved efficiency.
- **CONTINUOUS BLENDING** of crude, gelling agent and propping agents can eliminate batching.
- **BUILT-IN BREAKER** can be employed to speed return of fracturing fluid.
- **FLEXIBILITY** — proven to be effective over a wide range of depth and temperature conditions.

EXCELLENT PROPPING AGENT CARRIER due to the gelled structure of the treating fluid.



Investigate VIS-O-FRAC. It is one of many Halliburton fracturing techniques helping operators convert marginal wells into profitable producers the world over. See your Halliburton man *soon!*

first and foremost in formation fracturing

FRACTURING SERVICES

Halliburton
COMPANY · DUNCAN, OKLAHOMA

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Reed Cobra bits are just one example of the outstanding economies made possible by Reed's continuing program of research and development. These bits are setting phenomenal records all over the oil country in both mud and air drilling. For example—

On a West Texas well, drilling with mud below 12,000 feet, four Reed Cobra bits drilled 2,289 feet in 404½ hours. On an offset well it took 37 tooth bits to drill 2,172 feet in 558 hours. On another West Texas well a Cobra bit set an air drilling record of 3,644 feet in 103 hours.

In Pennsylvania, drilling with air, it is routine for one Reed Cobra bit to complete the hole from surface casing to TD. In this area total footage per Cobra bit regularly exceeds 7,000 feet.

Drilling with mud in East Texas in the tough Travis Peak formation Cobra bits consistently get runs up to 250 feet. Drilling with gas in Mississippi 10 Cobra bits drilled 6,850 feet in 358½ hours. In the same vicinity more than 10 times this number of tooth bits were required to drill the same footage with mud.

There is a Reed man near you. Let him give you the full story on Reed Cobra bits and the Reed Quality Line—tool joints, drill dollars and rock bits.

PIONEERS IN EFFICIENT DESIGN

REED COBRA BITS

IN MUD OR AIR

PENNSYLVANIA — 1 COBRA BIT,
8,352 FEET IN 134½ HOURS

WEST TEXAS — 1 COBRA BIT,
3,644 FEET IN 103 HOURS

FOUR CORNERS — 1 COBRA BIT,
4,102 FEET IN 134½ HOURS

MISSISSIPPI — 1 COBRA BIT,
1,317 FEET IN 51¾ HOURS

REED ROLLER BIT COMPANY

Houston 1, Texas • Export Office: Time and Life Bldg., Suite 3744 Rockefeller Center, New York 20, N. Y.—Reed Roller Bit Company (Nederland) N. V., Roosevelstraat 6, Leiden—Reed Roller Bit Company, Ltd., 4431 6th St. S.E., Calgary, Alberta

to waterflood operators who do not fracture wells

A few operators are still afraid to fracture waterflood injection and producing wells in spite of the fact that fracturing programs for waterflood projects are widely accepted. Here are some questions frequently brought up by these operators. The answers are based on records of thousands of treatments performed by Dowell.

QUESTION:

Will fracturing hasten breakthrough between injection and producing wells?

ANSWER:

Generally speaking, *no!* A poorly-designed fracture treatment of a producing well — performed too early in the life of a flood — can hasten breakthrough. In practice, however, this seldom happens.

Normally, breakthrough has been either unaffected or actually retarded by Dowell-engineered fracture treatments that were performed at the correct time.

QUESTION:

Will a premature breakthrough reduce ultimate economic recovery?

ANSWER:

If breakthrough does occur between an injection and a producing well, loss can usually be avoided by an appropriate change in the well pattern.

Dowell-engineered fracturing, however, has generally reduced, rather than increased, premature breakthrough.

QUESTION:

Will breakthrough to formation water reduce economic recovery?

ANSWER:

Loss can usually be avoided by changing the pattern of producing wells and injection wells. If formation water is likely to be a problem, however, Dowell engineers often design treatments to avoid breakthrough.

QUESTION:

Will fracturing affect water/oil ratios?

ANSWER:

Not in a consistent manner. Water/oil ratios may be increased, unchanged or reduced by fracturing. This is usually unimportant, however, since a waterflood that has been fractured should accommodate a higher water cut economically than one that is operated without fracturing. Dowell engineers design treatments on waterflood wells to avoid excessive water production.

QUESTION:

Will fracturing increase water handling costs?

ANSWER:

Fracturing programs have generally *reduced* water handling costs per barrel of oil produced. The daily costs of water handling may be increased, since so much more water is being handled, but oil production is usually increased so much that cost per barrel of oil is reduced.

Dowell engineers regularly design fracture treatments to minimize water pumping costs.

QUESTION:

Will fracturing costs reduce net profits?

ANSWER:

Fracturing costs have been negligible when compared with the savings realized. When successful fracturing programs are employed, fewer wells are required and well spacing can be wider. Since frac jobs are considerably less expensive than the drilling of new wells, the investment required for a given flood is decreased rather than increased by a successful, well-planned fracturing program.

When a successful fracturing program is initiated, daily production is increased while operating costs are affected little if at all; the result is lower operating costs per barrel of oil.

Dowell-engineered fracturing programs have been outstanding in helping waterflood operators increase net profits.

To summarize, waterflood operators have everything to gain by checking on the advantages of fracturing wells in a flood. For full information, call your nearest Dowell representative. Dowell services and products are offered from more than 150 offices and stations in the United States, Canada, Venezuela, Argentina, Germany, France and the Sahara area. Dowell, Tulsa 1, Oklahoma.

SERVICES FOR THE OIL INDUSTRY

DOWELL

DIVISION OF THE DOW CHEMICAL COMPANY

275 psi. At this well Williams contacted fluid in the hole at around 2122 ft. He started "mist drilling."

Fighting Formation Water

Mist drilling of necessity takes place when a combination of encroaching water mixes with the high rate of air being forced into the well by the compressors. The air and water mix with the cuttings which are forced up the hole and on out through the blooie line into the reserve pit.

The driller stayed on mist until he reached a depth of 6171 ft, where he encountered more fluid. Smith, the drilling foreman, was watching developments closely, and after conferring with all parties concerned, it was decided to begin drilling on fluid.

Although they had drilled on mist from around 2000 ft to below 6000 ft, they kept a standpipe pressure of 275 psi and had averaged about 37 ft per hr. However, as soon as they turned to fluid-drilling, penetration rates decreased to 18 ft per hr. Even so, the well was completed with an overall average penetration rate of 31 ft per hr.

When dust is lost and water encroachment is encountered, Williams starts the injection pump and injects soap into the air line. Yates used salt water foaming agent on the Continental State S-30 and it proved very effective.

Using and Maintaining Special Equipment Needed

Air manifold. About 10 ft out in front of the compressors is an 8⅝-in. pipe about 30 ft long called the air manifold. There is a flexible connection running from each of the compressors to this manifold. The purpose of the manifold is to assure an even flow of air into the well no matter how much pressure any one compressor is putting out. The air mixes in the manifold and is forced into the regular 3 in. air supply line which runs to the well.

The compression factor, however sufficient, represents a very large investment. It is estimated that the complete cost of equipping a rig will run to about $150,000. Even after the rig is equipped a maintenance crew is needed to keep the air-drilling machinery in operation. Since equipment can be leased on a contract basis, most drilling companies have found it more economical to procure the necessary equipment in this manner rather than to make the initial investment.

The ever-present conditions which are prevalent in air-drilling, particularly the dust, makes maintenance the contractor's biggest concern. The dust causes damage to the many working parts of the machinery, which neces-

HYCALOG

CONTINUING RESEARCH FOR LOWER COST DRILLING

2,931.0

A LONG NUMBER THAT SAVES DRILLERS THOUSANDS OF DOLLARS

That's the number of our U. S. patent on V-Door diamond bits. Developed by our own researchers, they have piled up a long record of saving big money for drillers. For example:

$17,500 saved in South Louisiana . . . $12,000 saved in Texas . . . $7,500 saved in Wyoming . . . $9,000 saved in Alberta!

These are but a few actual cases taken from our files.

Using the HYCALOG-developed "Core and Bust" principle, V-Door bits stay on bottom for long runs, reduce number of round trips and keep making hole for an exceptionally long life. All this adds up to what you're looking for . . . *lower cost drilling.*

Ask your HYCALOG *rep to show you some actual performance records on* V-DOOR *Bits. He has a stack of them.*

HYCALOG, INC.

505 AERO DRIVE, SHREVEPORT, LOUISIANA.

OFFICES IN PRINCIPAL OIL PRODUCING AREAS

DIAMOND BITS • CORE BARRELS • WELL LOGGING • DIAMOND CORING • CORE ANALYSIS • POWER SWIVELS

sitates overhaul jobs too often and are too expensive.

Normally Yates' drillers lay the "blooie line" through the substructure to the reserve pit. The blooie line is usually a 7-in. pipe and is laid to a distance of about 120 ft from the rig. When encroaching water is encountered as it was in Continental State S-30, the air pressure forces any excess water out of the hole into the blooie line and on into the reserve pit. From the time Williams encountered a small amount of water at 2122 ft, a steady small stream of about 1½-in. of water poured from the blooie line. The blooie line seldom causes any type of trouble in air-drilling.

When discouraging maintenance and other problems arise, Yates Drilling Company uses their equipment and know-how to try to overcome them, and they modify and experiment with unusual applications which are often needed in the drilling business. Therefore, they try to cope with any problem — compression, heat, pipe buoyancy, or whatever.

Comparing Techniques

When comparing the air-drilling technique with mud-drilling in the Abo, it has been noted that the average penetration rate has been increased by about 200%, and the average footage per bit some 750%. These percentages of course, will vary with different wells, since each well will encounter different problems, and no particular well will be an ideal situation.

The average penetration rate on Continental State S-30 No. 1 ranged from 90 ft per hr in dry drilling to 37 ft per hr in mist. When fluid was first encountered at a depth of 2122 ft, a penetration rate of about 31 ft was noted. This was on bit number three, which was a rebuilt bit. When Williams began mist-drilling the penetration rate slowed down somewhat during the course of that bit and bit number four. But bit number five was an experimental bit and was put into use at a depth of 3153 ft with a weight of 4000 lb and 40 rpm. This bit penetrated a total depth of 1519 ft in 49 hr, for a rate of 31 ft per hr. This maneuver seemed to produce desired results, so bits number six and seven were both experimental type. Although the well was finally completed with fluid, the average overall penetration rate never decreased below 31 ft per hr.

The lack of pipe buoyancy and the terrific heat in the summer poses special problems for the air-drillers. In the summer, Yates uses extra cooling equipment for the compressors, but there is still a problem of attaining enough compression, coupled as it is with the thinner air during the summer months.

Finding Abo Production

At the present time there are more than 210 wells producing in the Empire Abo field, with a production of more than 12,600 bpd. According to geologists, the reserves are expected to exceed 100 million bbl and may possibly last for a hundred years, depending of course upon future development along the reef.

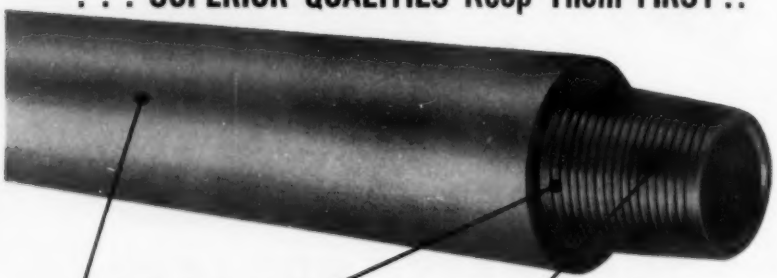
Today, the Empire field is one of the newest major oil discoveries in the Southwest and is probably the biggest. The depth of the wells will vary from 4500 ft to over 9000 ft. This may seem strange since the field is only about one mile wide. However, the altitude of the terrain will have something to do with this since the area is a rough rolling country.

Although drilling activity has slowed down somewhat during the early part of 1961 it is expected to pick up in the spring. Currently, there are five or six rigs operating in the Abo. Since this activity is located in a pretty good part of the established field little difficulty is anticipated in finding pay in these wells. ★ ★ ★

"Matched Tools for Unmatched Performance"

BAASH-ROSS TRUBORE DRILL COLLARS

. . . SUPERIOR QUALITIES Keep Them FIRST!!



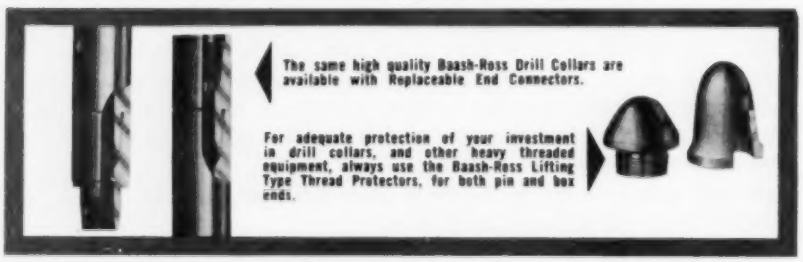
Baash-Ross Drill Collars are stress relieved to prevent bending in operation due to internal stresses.

Specified chemical analyses and heat treat processes result in mechanical properties 1" below the surface which insure maximum joint strength.

Impact tested to assure attainment of the desired metallurgical characteristics.

Thru the years these qualities of Baash-Ross Drill Collars have proven to be essential for maximum Collar life.

For additional information, write for Bulletin D1



The same high quality Baash-Ross Drill Collars are available with Replaceable End Connectors.

For adequate protection of your investment in drill collars, and other heavy threaded equipment, always use the Baash-Ross Lifting Type Thread Protectors, for both pin and box ends.

Call us for Your *Rental and Service* Needs . . . available in most areas.

OUR 42d YEAR OF PROGRESS

BAASH-ROSS

DIVISION OF JOY MANUFACTURING COMPANY

General Offices: Houston, Texas

SUPPLIERS' PARADE

New Companies, Subsidiaries, and Agents

Gaso Pump & Burner Manufacturing Company of Tulsa has appointed the **Midway Supply Company,** of Jackson, Michigan, distributors of its pumps in Michigan and Ontario.

Paul Huffacker, **Caribbean Oiltools,** C. A., in Puerto La Cruz, Venezuela, has been appointed sales and service representative for Venezuela by **Oil Metering and Processing Equipment Corporation.**

Robertshaw-Fulton's Sylphon Division, has designated **Turner & Company** of Metairie, Louisiana, as new sales representatives for the division in South Louisiana. Henry D. Turner, former New Orleans branch manager of Eggelhof Engineers, Inc., will be in charge of the sales office.

Dynel, Inc., a new firm to manufacture specialty products in the electromechanical instrumentation field has been incorporated in Los Angeles. Ray V. Long is president, H. Dickinson, vice president.

Appointments and Promotions

Armour and Company — **William Wood Prince,** chairman of the board; **Edward W. Wilson,** president.

Bradford Motor Works — **Ellis E. Branson,** sales representative, tri-state area of Illinois, Kentucky, and Indiana, formerly with Charles N. Hough Mfg. Company prior to its purchase by Bradford Motor.

Bovaird Supply Company — **William G. Rudd,** tubular sales manager, formerly with Lucey Products Corporation.

Bucyrus-Erie Company — **Frank T. House,** sales services manager in charge of field service, parts sales, dragline bucket sales, sales promotion and claims.

Byron Jackson Pumps, Inc. — **Reinaldo (Ray) Bibolini,** manager — foreign operations department in Los Angeles.

Continental-Emsco Company — **Rudd G. Seim,** manager, California division; **H. T. "Bud"** Haugh, replaces Seim as tri-state district manager.

Grove Valve and Regulator Company, a subsidiary of Walworth Company — **Kenneth F. Williamson,** vice president and product manager-valves.

Hagan Chemicals & Controls, Inc. — **Richard V. Whitty Jr.,** district manager of Tulsa oilfield division.

Hughes Tool Company — **H. W. Harms,** manager-export field engineering; **Roscoe R. Aulick,** product manager-industrial products; **N. B. Thomas,** product manager-tool joints; **John R. Hays,** manager-market research.

Jones & Laughlin Supply Division — salesmen: **L. V. Page,** Rock Spring, Wyoming; **J. B. Knauth,** Liberal, Kansas; **H. R. Long,** Natchez, Mississippi.

Magnet Cove Barium Corporation — **A. T. Robertson,** director of industrial relations, **Kenneth D. Reed,** assistant director.

National Supply Division, Armco Steel Corporation — **Jess D. McClendon,** manager of sales, **E. G. Krig,** manager of services, **Charles A. Chandler,** manager of merchandising, Western region; **Robert B. Hill,** wellhead sales supervisor, Southern region, and **Robert H. Caldwell,** Northern region; **Don Phillips,** plant engineer, Houston.

National Supply Company, Ltd. — **Brian A. Cooper,** regional manager of sales, Alberta, succeeding **D. L. Chandler,** who resigned.

Parkersburg Rig & Reel Company — **Luther Roy Latimer,** district manager, New Orleans.

Schlumberber Well Surveying Corporation — **S. J. Rusen,** manager, Ft. Morgan, Colorado; **H. E. Daniels,** location manager, Vernal, Utah; sales engineers — **R. D. Shay,** Roswell; **G. F. Horst,** Hobbs; **P. W. Goodlett,** Tyler.

Well Equipment Manufacturing Company — **Tom S. Andrews Jr.,** product manager-hamer products.

Oil Well Supply Division, United States Steel Corporation — vice presidents — **M. F. Hazel,** executive; **W. A. Weir,** sales; **Joe L. Ward,** store manager, Big Spring, Texas; area managers — **James E. Chenault, Jr.,** Canada; **R. L. Armstrong,** Rocky Mountain area; **L. M. Roy,** representative, Midland; **Paul H. Shepherd,** director of tubular sales, retired after 45 years' service. **William Mixkimins,** manager, store products.

Worthington Corporation, Standard Pump Division — **Theodore Davenport,** manager of planning; **Robert D. Rhodes,** manager of sales.

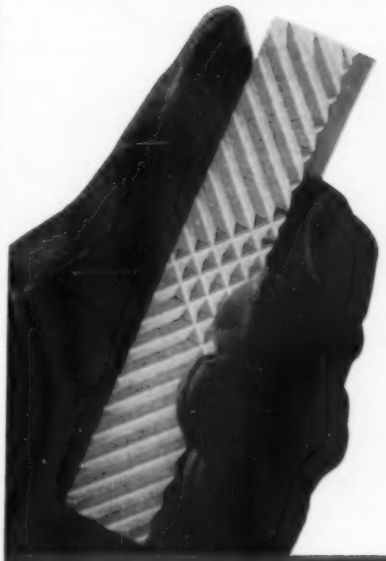
General News

Baker Oil Tools, Inc., as part of a new program to provide customers with sound technical advice on products, performance, technical hook-ups, etc., plans to permanently assign trained design engineers to its districts throughout the United States and many foreign areas. First move will be by R. A. Kent to Odessa, Baker's West Texas headquarters.

"Matched Tools for Unmatched Performance"

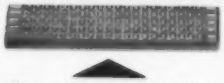
Web Wilson Sabre-Tooth Tong Dies

GRIP SECURELY-- TIME AFTER TIME



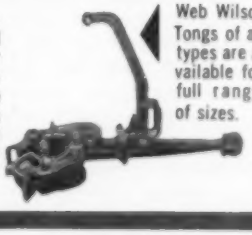
Choice of the industry, Sabre-Tooth Tong Dies are made from *triple-alloy* steel, heat treated in an advanced, carefully controlled process which adds carbon for a *hard exterior*, but leaves a tough resilient core. Angular teeth prevent deep biting, which protects the pipe. The *reversible feature* means longer die life. Corrosion is resisted by cadmium plating. Available for all sizes of tongs.

■ Specify *Web Wilson Sabre-Tooth Tong Dies* on your next order, and you too will recognize why they are the preference of the majority.



The popular Tiger Tooth Tong Die meets the same high metallurgical standards and is cadmium plated for corrosion protection.

"Jiffy" Tong-Die Driver and Slot Conditioner with its overhanging protective shield prevents flying chips, and automatically cleans the slot for the new die.



Web Wilson Tongs of all types are available for full range of sizes.

Call us for Your *Rental and Service* Needs
. . . available in most areas.

BAASH-ROSS
DIVISION OF JOY MANUFACTURING COMPANY
General Offices: Houston, Texas

OUR 42d YEAR OF PROGRESS
JOY

What's doing in DRILLING

Delta Drilling Acquires Six Rocky Mountain Rigs

Delta Drilling Company has acquired all of the drilling rigs and associated equipment of Exploration Drilling Company.

Announcement was made jointly by Joe Zeppa, president of Delta Drilling Company of Tyler, Texas, and Robert W. Berry, president of Exploration Drilling Company of Tulsa, Oklahoma. Consideration paid for the equipment was not disclosed.

Involved in the sale were six rigs located in Colorado, Utah, Wyoming and North Dakota, all of which will become part of Delta Drilling Company's Rocky Mountain Division. It will be operated from the company's Denver office.

Nearly all of the operating personnel of Exploration Drilling will become part of the Delta organization, practically all in the same capacity as previously.

Crews Vote to Continue Drilling Training Series

More than 90% of the 128 crew members, drillers and tool pushers of Baker and Taylor Drilling Company, Amarillo, Texas attending crew training voted to complete entire curriculum after covering 4 of 20 drilling conference topics recently.

Topics covered included lubrication of the rig, blocks and string-up; swivel and rotary; and the hydraulic system. Those remaining to be covered in the conference series prepared by American Association of Drilling Contractors include insurance, accident prevention, rigging-up, power generation, drawworks, compounds, hoses and belts, rig instruments, drill string, pumps, bits, wire rope, blowout prevention, drilling mud, formation testing, and casing.

Meetings were held alternately at Spearman and Perryton, and they drew almost 100% attendance despite bad weather. Meetings were scheduled by Max Banks, general manager of Baker and Taylor, and Jim Conway of University of Texas's Petroleum Extension Service conducted the meetings. Earl Bull, drilling superintendent for the drilling company also participated in the arrangements.

Conference series was initiated last year in the Permian Basin of West Texas with personnel of BBM Drilling Company, Great Western Drilling Company, and A. W. Thompson, Inc. participating. Conference has also been held in Canada in cooperation with University of Alberta where personnel of some 20 contractors participated.

Engineers Complete Course Covering Advanced Drilling

Engineers from eight states, Indonesia, Algeria, Mexico, and Canada recently completed an advanced drilling practices course at the University of Oklahoma in Norman. The 28 men attending the course represented 25 companies and they received instruction in the principal applications of recognized engineering practices used in drilling.

This includes selection and control of drilling fluids, a study of factors affecting penetration rate, a study of fluid hydraulics, a look at cementing practices, and a study of drilling economics based on rate of return calculations.

Objective of course was to provide techniques usefully in reducing well costs.

Big 6 Drilling Company Reelects Smith President

Big 6 Drilling Company officers for 1961 and 1962 have been named, with Weldon H. Smith reelected president for the twelfth time. The board of directors also named W. A. Stockard and H. "Buddy" Andres as vice presidents. Chester B. Benge is secretary-treasurer.

J. Brown Cutbirth was named a director.

Company operates three drilling rigs in the Upper Gulf Coast area from its headquarters in Houston.

Contractor Receives Award For Two Years of Safety

An award for operating two Helmerich and Payne, Inc. rigs for two years without a lost-time accident was received on behalf of the supervisors and crewmen by Lee Daniel, vice president of the contracting firm.

American Insurance Group of Dallas presented bronze plaques for this record, which was established from October, 1958 to 1960. Rigs No. 36 and 47 drilled over 170,000 ft of hole, including the world's deepest contract well, drilled by Rig No. 47.

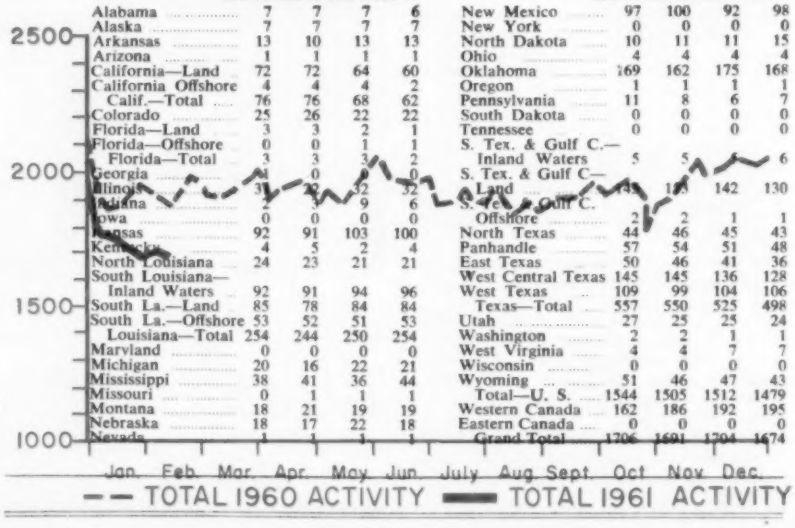
This well, No. 5 Rumberger, took over a year to drill and reached a total depth of 24,004 ft. "In spite of the fact that we were working at this extreme depth and with high pressures, we suffered no lost time accident during the record period", Daniel said. Even while at a depth of 20,000 ft, the slips were carrying more than 320,000 lb of drill string.

The men involved in drilling this well set many records, Daniel said, but the safety record was one that pleased him most.

Rotary Rigs Operating in Oil Fields of United States and Canada

As reported to American Association of Oil Well Drilling Contractors by Hughes Tool Company.

	Jan. 23	Jan. 30	Feb. 6	Feb. 13
Alabama	7	7	7	6
Alaska	7	7	7	7
Arkansas	13	10	13	13
Arizona	1	1	1	1
California—Land	72	72	64	60
California Offshore	4	4	4	2
Calif.—Total	76	76	68	62
Colorado	25	26	22	22
Florida—Land	3	3	2	1
Florida—Offshore	0	0	1	1
Florida—Total	3	3	3	2
Georgia	0	0	0	0
Illinois	31	32	32	32
Indiana	2	3	9	6
Iowa	0	0	0	0
Kansas	92	91	103	100
Kentucky	4	5	2	4
North Louisiana	24	23	21	21
South Louisiana—Inland Waters	92	91	94	96
South La.—Land	85	78	84	84
South La.—Offshore	53	52	51	53
Louisiana—Total	254	244	250	254
Maryland	0	0	0	0
Michigan	20	16	22	21
Mississippi	38	41	36	44
Missouri	0	1	1	1
Montana	18	21	19	19
Nebraska	18	17	22	18
Nevada	1	1	1	1
New Mexico	97	100	92	98
New York	0	0	0	0
North Dakota	10	11	11	15
Ohio	4	4	4	4
Oklahoma	169	162	175	168
Oregon	1	1	1	1
Pennsylvania	11	8	6	7
South Dakota	0	0	0	0
Tennessee	0	0	0	0
S. Tex. & Gulf C.—Inland Waters	5	5	5	6
S. Tex. & Gulf C.—Land	145	139	142	130
S. Tex. & Gulf C. Offshore	2	2	1	1
North Texas	44	46	45	43
Panhandle	57	54	51	48
East Texas	50	46	41	36
West Central Texas	145	145	136	128
West Texas	109	99	104	106
Texas—Total	557	550	525	498
Utah	27	25	25	24
Washington	2	2	1	1
West Virginia	4	4	7	7
Wisconsin	0	0	0	0
Wyoming	51	46	47	43
Total—U. S.	1544	1505	1512	1479
Western Canada	162	186	192	195
Eastern Canada	0	0	0	0
Grand Total	1706	1691	1704	1674



Ceremonies in Woodward, Oklahoma honored Rig No. 36 employees, including toolpushers Felix Holmes and Walt Young. A similar presentation was made to Roy Clark, toolpusher, and Ray Marsh, Helmerich and Payne district superintendent, at Rig No. 47 near Duncan, Oklahoma.

Rig and Equipment Cross South America By River

In one of the most ambitious rig and supply moves ever undertaken, Loffland Brothers Company moved a complete drilling rig across the Caribbean and then 2700 miles by river almost completely across South America from Brazil to the Peruvian jungle.

This put the drill site on the opposite side of the Andes from Lima on the Pacific Coast, and both crewmen and supplies fly over the 20,000 to 22,000 ft mountain range to the location.

To drill this deep wildcat for Mobil Oil Company in a dense tropical rain forest on the Aguaytia River, an obscure jungle stream, drilling equipment was assembled and checked out in Maracaibo, Venezuela. It included a rig with 138-ft mast and two 600-hp mud pumps, three large oilfield trucks, a welding truck, two tread-type tractors with dozer blades and booms, two air compressors, and a powered sand reel.

One ship, a 327-ft converted LST with a draft of about 15 ft carried the bulk of heavy equipment plus drill pipe and mud sacks. A smaller 157-ft ship with about a seven ft draft and front-loading ramps carried the trucks, tractors, and other equipment.

These ships floated the drilling package 1800 miles through the Caribbean to Belem, Brazil, then 2700 miles along the Amazon River and into its tributaries.

Upon arrival 20 miles from location, the smaller ship was delayed for five days because of low water in the river. Then torrential rains in the mountains to the west dumped enough water in a few hours to raise the Aguaytie River's level from 5 to 21 ft and float the ship off a sand bar. Then it served as a shuttle vessel to carry cargo from the larger vessel on the 110 mile trip from where it was moored at the mouth of the Aguaytia.

After unloading at the well site, crews put the equipment to work clearing the dense jungle growth for the location, access road and right of way. A 5000 ft landing strip with parking ramp, and additional drilling location joined by road to the first, boat landing, and office-dormitories at both locations have been built.

Loffland Bros. will drill their first well nearest the port.

No other sub-surface pump plunger has as many exclusive features as the Flexite Ring Plunger. Flexite Rings are made of a tough, hard fabric and phenolic resin compound and are precision ground for a "perfect circle" fit in the pump barrel. A special step-cut design allows each ring to expand to a highly efficient seal on the upstroke, and fall freely on the downstroke. Flexite Rings won't corrode, swell, nor disintegrate (even in sour oil), no pre-fitting nor soaking to size is necessary, and no special tools or fixtures are needed to make up the plungers. You can get them in all lengths and sizes for rod or tubing pumps. Your store or one of the many Harbison-Fischer representatives in all major pumping areas will be glad to give you illustrated literature containing full details, or write to us at P. O. Box 2477 in Fort Worth. There's no obligation.

HARBISON-FISCHER • • FORT WORTH

"BEST PUMPS IN THE OIL PATCH"®

HF

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

New Literature

Pipe Coatings, Inspection

Six-page brochure describes services Plastic Applicators and its various divisions offer, which includes plastic coatings, pipe inspection, electronics, and molded rubber products. Plastic Applicators itself provides corrosion-resistant plastic coatings to oil industry. Brochure describes firm's quality-control processes, application methods, and research facilities. Description also covers services provided by Pipe Inspectors Division, with illustrations of specialized equipment. Brochure outlines products and services of Plastronics Division, electronics and instrumentation division; and Rubber Applicators, molded rubber products and rubber lining division. *Plastic Applicators, Inc.*

Circle number (1) on reply card.

Triplex Plunger Pump

A six-page bulletin, No. 519, gives National's J-50 triplex plunger pump specifications and features. Keyed cross-sectional line drawings illustrate construction features of new 50-hp pump for waterflood service, power oil service, salt water disposal, and general lease service. Performance tables for three models with 12 plunger sizes show a capacity range of 138 gal per min at 560 psi to 15 gal per min at 5040 psi, at top rated speed. *National Supply Company.*

Circle number (2) on reply card.

Logging Slide Rule

Schlumberger's circular slide rule Zone Finder substitutes for charts and should aid operators who are not versed in detailed log interpretation. Zone Finder compares travel time, Delta T, from Sonic Log with true resistivity, Rt, from Induction Electrical Log to point out oil and gas bearing zones and zones which bear further investigating with sidewall coring or formation testing. Schlumberger bases method on their apparent water resistivity method and designed it for Gulf Coast formations of Louisiana and Texas. *Schlumberger Well Surveying Corporation.*

Circle number (3) on reply card.

Pipe, Flange, Fitting Data

A 10-in. slide card Albert Pipe Supply distributes gives pipe, flange and fitting information in a permanent slide-rule type card. One side contains tables of pipe sizes, schedule number, wall thickness, weight per foot and pressure at yield on pipe from ⅛ in. to 24 in. Reverse side of card furnishes data on welded flanges and fittings — sizes from 2 in. to 30 in., dimensions and weight per piece. Data on cast iron and steel flanged fittings, sizes 2½ in. to 18 in. furnished also. Company furnishes slide card without charge. *Albert Pipe Supply Company, Inc.*

Circle number (4) on reply card.

Fishing Tool Catalog

Wilson Supply's 48-page Fishing Tool catalog for overseas operators includes operational information, maintenance and spare parts catalog data, shipping weights and price information. Catalog also lists their sales points and overseas representatives. *Wilson Supply International Division.*

Circle number (5) on reply card.

Low-Voltage Equipment

General Electric's Buy Log, a 92-page catalog covering low-voltage distribution equipment, provides complete information on heavy-duty safety switches, current-limiting fuses, hinged wireway, circuit breakers, switchboards, motor control centers, power distribution centers, and many types of panelboards and busway. Publication includes product selector charts, descriptions, consolidated pricing tables, and a catalog number index. *General Electric Company.*

Circle number (6) on reply card.

Quick-Connect Line Pipe

A Continental-Emsco bulletin describes Green Triangle Speedline, a quickly-connected line pipe designed to withstand working pressures up to 1000 psi. Cutaway drawing shows how pipe slips into a welded-on threadless fitting. Bulletin gives a pictorial look at how pipe is stabbed and made-up. It includes specifications. *Continental-Emsco Supply Company.*

Circle number (7) on reply card.

70-hp Input Plunger Pump

Data sheet describing Gardner-Denver's PT-4 triplex plunger pump gives complete specifications. Pump operates at 70-hp input at 400 rpm and it serves in waterfloods and salt water disposal systems. Low pressure range covers 510 to 1563 psi while high pressure range reaches 1370 lb. Plunger sizes vary from 1¼ in. to 3½ in. by a 4-in. stroke, and its load reaches 4910 lb. Pump weighs 1370 lb. *Gardner-Denver Company.*

Circle number (8) on reply card.

it's powered
by a 37-hp
WISCONSIN
WISCONSIN-POWERED pneumatic bulk transport consists of a trailer-mounted Dowell twin-pump unit and a 37-hp Wisconsin Engine direct-connected to a Gardner-Denver air compressor.

air-operated bulk transport speeds cementing of oil wells

The Wisconsin-powered unit shown is tailored for fast, low-cost cementing of oil wells. Its capacity of 590 cu. ft. at a discharge rate in excess of 50 cu. ft. per minute assures continuous mixing and cementing, regardless of job size.

The plant is extremely flexible. The manifolds on each of the twin-pump units are arranged for discharging cargo through the surge tank in the rear — or through one on any other transport. Thus you can use a single surge tank to unload a fleet of transports without moving them or the mixing hopper.

The 37-hp VG4D is precision-built for continuous mixing and cementing. Its high torque takes changing loads in stride without stalling. Heavy-duty design and air cooling combine to give the most power service with the least care over a wide range of temperatures.

Let us tailor the Wisconsin Engine you need for your utility units. Sizes 3 to 56 hp. Get Engine Bulletin S-254.

WISCONSIN
MOTOR CORPORATION
Milwaukee 46, Wis.

WRITE TO HARLEY SALES CO.
619 SOUTH MAIN STREET • TULSA, OKLAHOMA
3420 MC KINNEY AVENUE • HOUSTON, TEXAS
805 SOUTH MAIN STREET • WICHITA, KANSAS
Oil Field Distributors for Wisconsin Engines and all types of Utility Units

World's Largest Builders of Heavy-Duty Air-Cooled Engines

J-286

Subsurface Recorders

Catalog from Kuster features subsurface pressure and temperature recorders company manufactures. It also includes fishing tools, replacement parts and supplies, and a 24-hour rental service. *The Kuster Company.*

Circle number (9) on reply card.

Fracturing Pellet

Brochure from Reynolds Metals describes their recently-introduced Frac-Shot, an aluminum pellet propping agent. It gives pellet specifications, particle concentration and other preliminary data from field and laboratory results. Pictures and drawings illustrate what pellets should do under actual well conditions. *Reynolds Metals Company.*

Circle number (10) on reply card.

Residual Gas Analyzer

Continuously analysing gas remaining in evacuated systems, CEC Residual Gas Analyzer is described in a two-page, illustrated bulletin which gives specifications and capabilities. Instrument measures minute quantities of gas, gaseous mixtures, and vapors over a wide mass range. *Consolidated Electrodynamics Corporation.*

Circle number (11) on reply card.

Trussed Pumping Unit

Introductory brochure describes and illustrates Bethlehem Steel's new Series 60 pumping unit with a design concept called integrated truss-construction. Other features discussed include a servicing platform, pre-lubricated bearings, hydraulic wrist pins, and improved gear reducer, counter-balance cranks and a fold-under horsehead. *Bethlehem Steel Company.*

Circle number (12) on reply card.

Porcelain Enameled Aluminum

A booklet "Questions and Answers About Porcelain Enameled Aluminum" has been published by Reynolds Metals. It contains 24 questions and answers in an eight-page booklet. *Reynolds Metals Company.*

Circle number (13) on reply card.

Treating Data Sheets

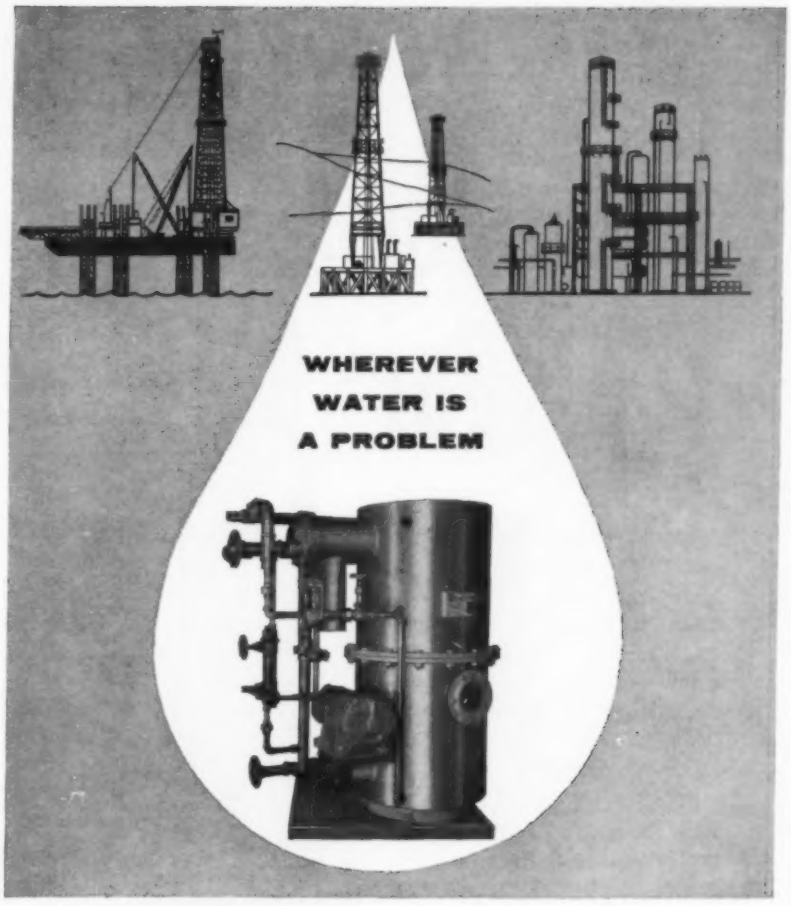
Four Dowell product data sheets discuss Gypban, complex phosphate compounds used to retard deposition of gyp in and near well bores, on down-hole equipment and on surface well equipment; Freflo, a mixture of oil-soluble demulsifying chemicals and surfactants; G2 and G4 liquid foaming agents; and Ezeflo, a concentrated, low pour-point, water-soluble, nonionic surfactant used primarily to reduce pressures required to inject water into wells. Data sheets give description of products and applications. *Dowell Division.*

Circle number (14) on reply card.

Underground Pipeline Wrap

Catalog giving details about fiberglass inner and outer underground pipe wraps has been produced by Owens-Corning Fiberglas. Both inner and outer wraps have been tested for reinforcement against outside pressures and corrosion. Microphotos in booklet show how glass yarns and fibers are bonded to make wraps, and other photos in color and black-and-white illustrate applications techniques in field and mill. Technical tables guide proper thicknesses, widths, laps, and other information. *Owens-Corning Fiberglas Corporation.*

Circle number (15) on reply card.



AQUAVAP

HEAT RECOVERY EVAPORATORS

ARE THE FUEL-FREE, LOW COST ANSWER

Sold as a complete packaged unit, low in initial cost, inexpensive to maintain, and simple to operate, AMF-Maxim Aquavap evaporators are ideal for use offshore or on land. They convert salt or brackish water to fresh water, using engine jacket water or any other available hot water as a heat source. Thus their operation is fuel free. Five models are available with capacities ranging from 150 gallons per day up to 12,500 gallons per day. The purity of water produced exceeds U. S. Dept. of Health requirements.

Aquavaps are extremely compact. A unit providing, for example, up to 1,000 GPD is less than 4 feet high and laterally takes only about 2 x 4 feet of floor or deck space. Such a unit would weigh approximately 700 lbs. Other types of AMF-Maxim evaporators are available with capacities ranging from 150 to more than 1,000,000 gallons per day. For further information on the Aquavap, write to our Waterford address below.

AMF MAXIM EVAPORATOR DIVISION
American Machine & Foundry Company
WATERFORD, CONN. • Branch, DENVER, COLO.
Represented by THE J. B. BEAIRD COMPANY
Shreveport, New Orleans, Tulsa, Midland, Houston, New York

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

SEAL SECURELY··

with the...

oilmaster

AUTOMATIC

Top Seal

Large ports insure rapid fluid by-pass.

Positive seal against sand and foreign matter.

Metal sleeve molded to rubber assures positive removal of seal with pump.

Anti-swivel splines clutch pump to rod string.

Plunger bump cannot release rubber.

A stationary barrel bottom anchored pump **CAN** be run safely in sandy wells . . . when coupled with an **OILMASTER Automatic Top Seal.** The Top Seal eliminates the hazard of stripping jobs by effectively sealing the annulus between the pump and tubing. It also reduces pull rod wear by stabilizing and centering the top of the pump.

OILMASTER's Top Seal is fully automatic . . . it requires no special actuation to set or pull. When the pump is seated, the weight of the rods expands the rubber against the tubing, sealing out sand and foreign material. When the pump is pulled, large ports allow fluid to drain rapidly past the Top Seal and the controlled expansion rubber is pulled intact with the pump.

Ask your **OILMASTER** or **National Supply** representative to demonstrate the advantages and economies of the **Automatic Top Seal,** or contact these co-distributors: **Beacon Supply Company, Dominion Oilfields Supply Company, Limited, Industrial Supply Company, Union Supply Company. For literature write to FLUID PACKED PUMP, 9100 S. Norwalk Blvd., Los Nietos, Calif., and ask for Bulletin 6101.**

ARMCO **National Supply Division**

Tubing Joints Data

Fold-out data sheet on tubing joints, Catalog No. DS-61 is available from Hardy-Griffin Engineering Corporation. Integral joint comparison table covers connections of four companies for nominal sizes from ¾ in. to 4½ in., including weight per foot, wall, ID drift, upset OD, nominal ID, bored ID, make-up torque, and efficiency. Folder gives API tubing data, API casing data, calculation of running clearance in casing, multiple tubing installations using one size, stress table, mud table, tubing formula, and thread forms. *Hardy-Griffin Engineering Corporation.*

Circle number (16) on reply card.

100 - 210 Hp Diesel Engine

Features of recently-introduced Allis-Chalmers Models 10000 and 11000 diesel engines are described by illustrated text of two-color, eight-page catalog BU-718. Performance curves and charts, and illustration including cutaways of important components are included to explain the title "A New Kind of Diesel Work Power." Engines are in 100 to 210 hp class. *Allis-Chalmers Manufacturing Company.*

Circle number (17) on reply card.

Casing Deep Wells

Casing deep wells with Pittsburgh Seamless Buttress Thread Casing is detailed in a four-page folder. Brochure contains a minimum performance properties chart based on three grades of steel and outside diameters of 5½ to 9⅝ in. *Pittsburgh Steel Company.*

Circle number (18) on reply card.

Coating for Hot Metal

Sili-Kool, a combination of silicon and atomized aluminum, coats stacks, boilers, hot air pipes, diesel and gasoline engine manifolds, mufflers, and vapor or steam pipes which generate extremely high temperatures. Illustrated pamphlet shows test results in stopping corrosion. *C. H. Dragert Company, Inc.*

Circle number (19) on reply card.

Ton Mile Calculator

A round-trip ton mile calculator has been released by Macwhyte Wire Rope for figuring ton miles per round trip. Calculator is 4¾ in. wide by 10½ in. long with large type. There are two slides to compute ton miles for depths to 30,000 ft using drill pipe up to 6⅝-in. diam. Step-by-step directions are included on calculator slide-rule. *Macwhyte Wire Rope Company.*

Circle number (20) on reply card.

Automatic Tank Gages

A four-page bulletin describes Varec's Fig. No. 2500 Series high-pressure automatic tank gages. It includes installation diagrams of tank gages, designed for 150 lb and 300 lb range in small, high-pressure tanks; larger high-pressure tanks, or top-reading high-pressure tanks. *Vapor Recovery Systems Company.*

Circle number (21) on reply card.

Two-Cycle Gas Compressor

Bulletin No. 188 introductes Clark's Model TCV, largest two-cycle gas-engine driven compressor built. Turbo-charged V-engine models with 12 or 16 power cylinders are rated at 4000 and 5000 bhp, respectively. As many as eight power cylinders may be mounted, and bulletin discusses and illustrates design and construction. *Clark Bros. Company.*

Circle number (22) on reply card.

NOW
MORE DRILLING INFORMATION

THE MODELS G7PW OR G7TW RECORDER

These models of the Geograph Recorder were developed particularly for the contractors and operators desiring more detailed, recorded data concerning the four drilling variables—Rate of Penetration, Drilling Weight, Pump Pressure and Torque. This information is required to compete in today's highly competitive drilling situation.

Geologists obtain more information about rate of penetration and sub-surface formations and toolpushers are supplied with the information necessary to determine the optimum drilling rate for a particular formation.

Engineers and contractors can readily interpret the recordings of weight on bit, pump pressure (or torque), downtime, rate of penetration, tightspots and bit wear in making accurate decisions regarding existing drilling conditions.

The result: more hole per dollar.

When you drill your next well, specify the Model G7PW or G7TW Recorder. For additional information, ask for Catalog No. 220, or call your nearby Geograph Oil Field Services office.

GEOLOGRAPH
OIL FIELD SERVICES
P. O. Box 1276
Oklahoma City 1, Okla.

SECONDARY RECOVERY

PETROLEUM ENGINEERS
STEPHENS ENGINEERING
WICHITA FALLS, TEXAS

RESERVOIR ENGINEERING
Water Flooding Gas Repressuring
EVALUATION CORE ANALYSIS
SURVEYS ECONOMICS
Cost Estimates, Design, Installation
FIELD SUPERVISION
Phone 723-2167

NEW LOW-COST, EFFICIENT

CHEMICAL PUMP

for wells with corrosion, scale or wax conditions

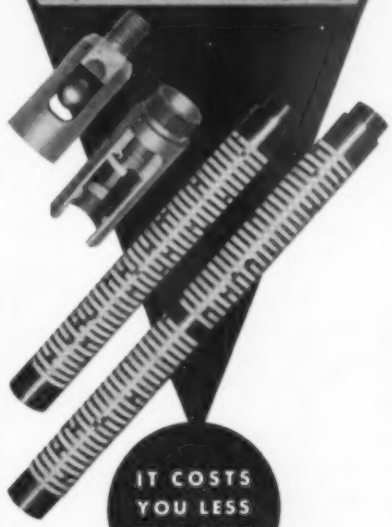
The new Pacific Chemical Pump will deliver 5 to 150 gallons per day. Once it is set, the injection of treatment solution is constant.

Precision made of high quality materials to safely withstand working pressures to 1000 P.S.I.

Write, Wire or Phone For Details

Pacific
PERFORATING CO., Inc.
Torrance, California
Telephone SPruce 5-3269

Let R-u-b-b-e-r Take The Wear
in your sucker rod pumps



IT COSTS YOU LESS THAT WAY

- MARTIN RUBBER & DUCK RINGS give excellent life in dirty abrasive fluids . . . high or low gravity . . . much or little water . . . shallow or deep wells. They last for years in the easier pumping wells. Replacement rings cost comparatively little.
- MARTIN PLUNGER BODIES, precision grooved, drilled and threaded (no underneath fluid passage), usually last for years. Tube or barrel costs are often cut in half.
- The replaceable SYNTHETIC RUBBER GUIDES in MARTIN CAGES last longer than any metal, and the cushioning of the ball increases your ball & seat life. Results are often truly amazing. (Patent No. 2,591,174)

Write for our new catalog or see it in the Composite (24th Edition). All products sold thru supply companies.

JOHN N. MARTIN
Manufacturer
9 W. BRADY STREET • TULSA, OKLAHOMA

EXPLORATION ACTIVITIES

New Seismic Method Matches Vibration Waves

An entirely new system of seismic exploration, Vibroseis, eliminates use of buried explosive charges or dropping weights. Continental Oil Company developed the system and licensed Seismograph Service Corporation of Tulsa, Oklahoma, to offer service in foreign areas.

Tested for several years in Continental's domestic production operations, system uses vibrators located on earth's surface to generate seismic waves. New-type vibrators allow geophysicist to control signal sent into the earth closely, G. H. Westby, president of Seismograph Service said.

Master control signal introduces frequency that is most applicable into the earth and keeps identical vibrators operating in phase.

ALASKA

Fifth Flowing Well Boosts First Natural Gas Field

Potential of Alaska's first commercial natural gas field has been increased substantially through completion of a fifth flowing well on Kenai Peninsula, Union Oil Company of California and Ohio Oil Company, joint owners, reported.

Well extends producing area more than two miles south of previously-drilled wells. It flows 5300 Mcf of gas per day through a ⅜-in. choke from a perforated interval 5688 to 5728 ft with 1550-lb tubing pressure.

CALIFORNIA

Fourth Producer Shows Promise From Samples

Nordon Corporation, Ltd., brought in its fourth straight well without a dry hole in the Helm field of Fresno County, California.

Electric log and samples indicate that well, Noble 4-9, will produce about the same as the first three, which currently produce an average of 525 bbl of 35 deg gravity oil per day commercially. Well bottomed at 6947 ft in Miocene zone and will go into commercial production immediately.

CANADA

Two Gas Wells Completed In British Columbia

Western Natural Gas Company, Inc. and partners completed two gas wells in British Columbia, Canada.

Kathy b-30-F, a Middle Devonian gas well, flowed at a rate of 9890 Mcf per day on ½-in. choke at 1525-lb tubing flow pressure. It was completed five miles from nearest producer. Nelson b-70-I, also a gas well with production from Middle Devonian formation, flowed at rate of 10,300 Mcf per day on a ½-in. choke, with 1725-lb tubing flow pressure.

LIBYA

Initial Production Tests Indicate Major Producer

Controlled initial production testing of Raguba-1, a discovery well in Cyrenaica province of Libya, resulted in production rates of 494 bbl per day of 40.5 deg oil through a ¼-in. choke and 2250 bbl per day through a ½-in. choke.

Well's gas and oil-bearing section measures 220-ft below 5280 ft, and operator Esso Sirte, Inc. anticipates increasing production to 5000 bbl a day by opening additional section and acidizing.

LOUISIANA

Gas-Condensate Well Flows 10,000 Mcfd

Union Oil Company of California discovered a gas-condensate well on Northwest Lac Blanc Prospect, Vermilion Parish, Louisiana.

Completed from interval 14,352 to 14,362 ft, well flowed 10,000 Mcf per day and 266 bbl of condensate per day with exceptionally high pressures. Company leaseholds total 6300 net acres on prospect and program of development drilling will begin soon.

NEW MEXICO

Wolfcamp Flows 776 Bpd In Lea County Discovery

Phillips Petroleum Company's Wolfcamp zone oil discovery in their 18,560-acre Maljamar field in Lea County, New Mexico, flowed at a rate of 276 bbl of 40 deg gravity crude daily from lower portion of a 560 ft gross pay section. New well, No. 9 Leamex, flowed from perforations beginning at 10,622 ft. Gas-oil ratio was 1000 to 1.

PENNSYLVANIA

State Will Furnish Map For State Forest Leases

Division of Minerals, Pennsylvania Department of Forests and Waters, will soon furnish a map to indicate location and extent of oil and gas leases on state forest land.

Composite map will show most leases, and supplementary maps will show a few additional ones. This location map will supplement Deep Well Oil and Gas Map of Pennsylvania, and state will furnish it without charge.

TEXAS

Two Jackson County Wells Flow 11,000 Mcf Per Day

Ambassador Oil Corporation of Fort Worth brought in two sizable gas discoveries.

A Frio sand discovery gas well in Jackson County, Texas, 25 miles northeast of Victoria, flowed an open flow potential of 11,000,000 cu ft per day. Another in Douglas sand of Lipscomb County, Texas, registered an open flow potential of 15,750,000 cu ft per day after fracturing.

Prolific Gas Well Flows Calculated 165,000 Mcfd

Mobil Oil Company completed a prolific Ellenburger gas well in Terrell County, Texas, 29 miles northeast of Dryden and 1¾ miles northeast of Brown-Bassett field.

No. 1 Banner-State flowed a calculated 165 million cu ft of gas per day through perforations at 13,370 ft to 13,423 ft and in open hole between 14,423 to 14,529 ft. Dually-completed West Texas well also produces in a Strawn gas formation through perforations between 11,584 and 11,604 ft.

Well flowed gas during drilling at a daily rate of 15,000 to 20,000 Mcf per day during a test of Fusselman formation between 12,270 and 12,430 ft.

Lower Frio Rank Wildcat Flows Gas Near Palacios

Completing a Lower Frio rank wildcat four miles west of Palacios in Matagorda County, Pan American Petroleum Corporation drilled to total depth of 16,000 ft and plugged back to 11,735 ft.

1 Silver Lake Ranches Inc. flowed at an average rate of flow through perforations between 11,716 to 11,732 ft with an average rate of flow of 2400 Mcf per day of gas, 89 bbl of 52.1 gravity distillate and 47 bbl of water on various chokes.

Two Dual Oil Completions Flow In Kingfisher County

Sunray Mid-Continent Oil Company dually completed a pair of Kingfisher County development wells. No. 1 Steward in College Corner Pool flowed 340 bbl of oil per day on a 28/64-in.

choke from Manning perforations at 6627 ft and 400 bbl oil daily on a 20/64-in. choke from Meramec open hole at 6833 to 7030 ft.

Tubing pressure was 400 lb, total depth 7030 ft. In North Dover pool, another dual flowed 340 bbl daily on a 20/64-in. choke from Oswego formation openings at 6498 to 6506 ft. Flow of 156 bbl per day on a ¼-in. choke was gaged from Manning perforations at 6498 to 6506 ft.

Five Gas Wells Flow In 100,000 Mcfd Range

Five gas wells with potential flows in 100,000 Mcf per day range have been completed in South Texas counties.

Two of these widely-scattered wells rank as wildcats, Slick Oil Corporation's 1 Pekar, Brazoria County, with 117 million cu ft per day in Frio sand at 9947 to 9961 ft; and William K. Davis 1 Edrington, McMullen County, with 120 million cu ft per day in Wilcox-Luling sand from 7761 to 7766 ft.

Other wells are Skelly Oil Company's 1-D Cobb, Bay City field, Matagorda County, 131 million cu ft from two zones of Frio sands, 8253 to 8259 ft and 8328 to 8334 ft; Standard Oil Company of Texas 2 Holbein, Northeast Thompsonville field, 129 million cu ft Wilcox sand from 9493 to 9566 ft.

Cameron County well is Shell Oil Company 2 Luttes, Miocene sand, 6564 to 6572 ft. It is a two-mile extension of Luttes field, which was found less than a year ago.

New Quintuple Completion Found In McFaddin Field

A second quintuple oil and gas completion has been made successfully in McFaddin field of southern Victoria County, near the Central Gulf Coast.

In addition to two quintuples, McFadden field has a sextuple well, completed earlier this year on an adjoining lease. All three completions have been made by Sunray Mid-Continent Oil Company.

The sextuple completion was the second ever made. The first, also made by Sunray Mid-Continent, was made last year in the North LaWard field, in adjoining Jackson County.

The new well is oil-productive from perforations at 5471 to 5475 ft and gas-productive from pays at 5130 to 5225 ft, 5225 to 5230 ft, 5514 to 5519 ft, and 6530 to 5635 ft.

The oil zone flowed 123 bbl daily through ⅛-in choke with flowing pressure of 650 psi, and gas-oil ratio of 569 cu ft per bbl. Gravity of the oil is 38.2 degrees. Over-all gas potential is 34,200 Mcfd.

going for a barrel full of answers...

To complete or not to complete . . . and if so, where? Porosity? Permeability? Oil in place? Net pay? The round-trip this core barrel will make is the *only* method of bringing reservoir material under the cold light of reality — the only *direct* procedure for providing a factual framework for geological, engineering, and management decisions.

Give it some hard thought for a moment. Consider how much *more* important each exploratory well is today than it was several years ago — to the operator and to the investor. Consider how *little* it costs to obtain basic measured data versus the applications it has — *from discovery to depletion.*

Core Analysis is not a luxury. The absence of it is.

Core Analysis Brochures are immediately available. Please make request on your company letterhead and include name of magazine in which this ad appears.

CORE LAB

CORE LABORATORIES, INC.

BOX 10185 DALLAS 7 TEXAS USA • CABLE ADDRESS CORELAB

UNITED STATES CANADA SOUTH AMERICA EUROPE AFRICA

DOUBLE-E
POLISHED ROD LUBRICATOR

Prevents burn-out of stuffing box packing

Maintains thin film of oil on polished rod at all times; is a self-contained, entirely automatic unit which rests on top of any stuffing box. Tool is held down by its own weight, is interchangeable on following rod sizes: 1⅛"; 1¼"; 1 5/16"; 1 7/16"; 1½"; 1¾".

Sold Through Supply Stores
Write for Catalog and Prices

EQUIPMENT ENGINEERS, INC.
2039 Amelia St., Dallas 35, Texas
LAkeside 6-3873

leaders for 30 years in well completion & pumping equipment

EZY-VUE
PRESSURE GAUGE

THE FIRST ACCURATE PRESSURE GAUGE For Applications Requiring... RUGGEDNESS and DEPENDABILITY

CAPACITIES: 3,000, 5,000, 6,000, 10,000, 15,000 PSI Metric Equivalents Available.

MARTIN DECKER

WRITE FOR DESCRIPTIVE LITERATURE E-85
MARTIN-DECKER CORPORATION
3431 CHERRY AVENUE, LONG BEACH 7, CALIF.

World's principal manufacturer of Oil Well Drilling Instrumentation

IN OVERSEAS OPERATIONS...

GLOBE MODEL "N" JUNK CATCHERS

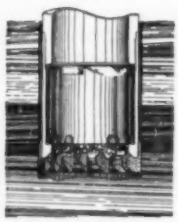
ARE AS VITAL AS A VISA!

...and it's the only Junk Catcher with interchangeable Magnetic and Dog Type Catchers.

Wherever you may be—from here to breakfast—you'll find that the Globe "Model N" is the standard Junk Catcher for the industry. It's a fast, dependable fishing tool so simple in design, construction and operation that any crew can run it with complete assurance of full recovery of all types of loose junk.

The Globe Junk Catcher uses both a magnetic or dog type catcher—and each is interchangeable so that only one complete outfit is required. Operators appreciate the maximum flexibility in operation and recovery with a minimum of equipment and investment.

Why **don't you investigate the advantage of this low cost "insurance" on your next job? Write for descriptive literature.**



Globe Magnet type catcher. Circulation flows between basket head and magnet.

Both the upper and lower catcher dogs serve to hold ANY load securely while coming out of the hole.

GLOBE OIL TOOLS

GLOBE OIL TOOLS CO.

Main Office and Plant: LOS NIETOS, CALIFORNIA

Branches maintained in all principal drilling areas

It's New

Drilling-Producing Equipment

Pressure Gage Line

Skinner Bros. added a complete line of oil field pressure gages to its current list of products, which includes four types in 49 pressure ranges and four popular dial sizes. Types include Imperial, pressure ranges to 10,000 psi; Hydro-King, pressure ranges to 5000 psi; Citation, pressure ranges to 1000 psi; and Monitor, for pressure ranges up to 1000 psi. *Skinner Bros. Company, Inc.*

Circle number (23) on reply card.

Electrically Sensing Flow

Non-mechanical solid state electrical unit reports flow or lack of flow conditions in pipelines at flow rates down to 3 gal per hr. No vanes or probes restrict flow-crude's gravity, and cut of crude doesn't affect device. It compensates itself for temperature variations between 32 and 130 F with pressures to 1000 psi. With a one-piece explosion-proofed sensor body, device uses a-c, d-c or battery power with current drain of less than two watts. Company designed device particularly for oil field automation for sensing and reporting individual well "pumped off" conditions to central operating station. *Flotec Corporation.*

Circle number (24) on reply card.

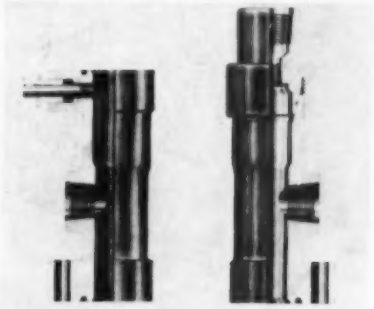
Three Voltage Pump Motor

Reliance Electric and Engineering's oil well pump motor operates on either 220, 440, or 762 volts. Feature permits selecting operating voltage at time motor is installed. This permits moving motor from field to field. Motors range from 5 to 50 hp with triple-selection voltage or up to 125 hp with specified voltage. *Reliance Electric and Engineering Company.*

Circle number (25) on reply card.

Macaroni Tubing Heads

Line of Type M tubing heads for 1½-in. and smaller tubing has been introduced by Oil Center Tool. O-C-T tubing heads were designed to meet current needs for multi-



ple and tubingless completion wellhead equipment. Heads can be supplied with either flanged or threaded connections on top and bottom. Crescent flanges, triflanges, and quadruple flanges are available. Three hangers have also been introduced for use in these heads. Models include a threaded hanger, threaded hanger with back-pressure-valve grooves, and a stripper hanger. *Oil Center Tool Company.*

Circle number (26) on reply card.

Detector Spots Corrosion

Electronic instrument developed by a group of California research engineers detects corrosion spots from outside of casing, whereas all present detectors operate on inside wall. Shell Development tool measures precise thickness of steel walls which line a well from top to bottom. Sensitive device, designed to spot a thinning in casing of 1/200-in. deep, should detect bit of corrosion in time for corrective treatment. *Shell Oil Company.*

Circle number (27) on reply card.

LACT Production Unit

A Lease Automatic Custody Transfer unit with positive displacement meter has been developed by National Tank. Unit meets requirements of both producers and pipelines, needs only four connections for operation. When oil from storage passes

IT BEGINS HERE!..

Here, in this modern, spacious plant in Butler, Pennsylvania, is where the enviable Spang reputation begins—a reputation known everywhere and wherever cable system drilling and fishing tools are used.

Here men with cable tool savvy constantly strive to improve tool design, to upgrade metals, to speed up manufacturing processes. All this with an eye to making a good drilling or fishing tool BETTER!

True, the reputation that begins here reaches out to every cable tool rig using Spang tools . . . making a good drilling operation BETTER!

SPANG & COMPANY

BUTLER, PENNSYLVANIA

BRANCHES: Bolivar, N. Y. • Mt. Pleasant, Mich. Winfield, Kans. • Cisco, Texas

For over 60 years manufacturers of BETTER Cable System Tools for Oil, Gas and Water Well Completion.

"LATE LIGHTS" To Serve You . . .

Seeking . . . and finding, better communication systems is part of our life at USI. Sure in the knowledge that one of our systems can serve you best, we invite your next bid. Better still, why not call us today!

TYPE 50A PX

TYPE 50B PX

UNITED STATES INSTRUMENT CORP., CHARLOTTESVILLE. VIRGINIA

20 hrs. & 800 miles LATER...

Circulation regained!

Over the rig noise—"SHUT 'ER DOWN!" Circulation lost at 12,400 feet. A rush for the phone . . .warehouse doors sliding back in Tulsa . . . the big Montello Diamond T hits the road with 35,000 lbs. of PHENO-SEAL. Order received, processed, loaded, and delivered to location in 20 hours. Mister, THAT'S service!!

Montello's private truck fleet provides emergency delivery AND keeps major and local mud service warehouses "well supplied." Your PHENO-SEAL representative will give you the story on availability. Having engineered the mud on hundreds of wells himself—he's on YOUR side.

PHENO-SEAL

MONTELLO, INC.
Box 5334 Tulsa, Oklahoma

Sales Representatives—

Pheno-Seal Sales Co.		Circulation, Inc.	
McAllen, Texas	MU 6-3943	Borger, Texas	BR 4-3033
Lafayette, La.	CE 5-6945	Pampa, Texas	MO 4-2671

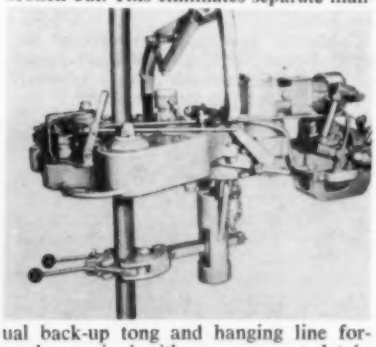
You will find PHENO-SEAL available through the nation-wide warehousing facilities of all progressive mud service companies.

a bs&w monitor probe, fluid not meeting pipeline specifications is re-routed to treater or wet oil storage. A positive displacement meter with automatic temperature compensation records pipeline quality oil. Proportionate samples are taken during delivery, and a back pressure and shut-off valve is designed to insure accurate meter operation and positive control. Varied lease requirements can be provided for with in-stock accessories. *National Tank Company.*

Circle number (28) on reply card.

Semi-Automatic Back-up Tool

Byron Jackson Tools designed a semi-automatic back-up attachment to prevent lower section of tubing string from turning in slips while a stand is made up or broken out. This eliminates separate manual back-up tong and hanging line formerly required with power-operated tubing tongs. Spring-balanced to aid vertical positioning, a sliding lever allows horizontal spotting and provides complete access to tubing joint in retracted position. Operated with a toggle switch to grip or release pipe, back-up fits tongs in 2⅜-in., 3½-in., and 4½-in. jaw sizes. *Byron Jackson Tools, Inc.*



Circle number (29) on reply card.

High Pressure Pump

Gaso developed its Series 3400 Horizontal Triplex Plunger Pump to provide high pressures in small-volume waterflood projects and well servicing operations. Pump measures 4¼-in. to 2-in. by 4-in. pump with a high pressure fluid end and a single suction. It runs at 350 rpm developing maximum capacities and working pressures of 31.5 bbl per hour at 3500 psi with 1¼-in. plungers and 81 bbl per hr at 2000 psi with 1-in. plungers. *Gaso Pump and Burner Manufacturing Company.*

Circle number (30) on reply card.

Engine Safety Device

Schafer Oil and Heat Sentinels, designed to cut off any engine powered by gas or liquid when oil pressure of engine drops to a pre-designated low or heat generated rises above a set danger point, will fit any engine. In liquid fuel model, engine pressure moves internal piston 3/16 in. upward in switch to allow fuel flow. When oil pressure falls below minimum, a pressure spring pushes piston downward to cut off fuel supply. This model uses ⅜-in. tapped holes for fuel lines. Gas fuel model operates on same principle, except that piston opens a butterfly valve to allow fuel to flow through. It takes 2-in. OD fuel lines and adapters allow use of any size line. Pressure springs installed range from 4 to 30 lb. *The Happy Company.*

Circle number (31) on reply card.

Well Pumping Controllers

Line of oil well pumping controllers for standard or inherently-protected electric motors serve in outdoor operations requiring full-voltage starting of polyphase motors up to 100 hp. Rated at either 220 or 440 volts, two methods of programing and restarting allow using a program timer with a built-in random sequence restart feature or toggle tabs that permit 24-hour timing cycles with intervals down to 15 minutes. *General Electric Company.*

Circle number (32) on reply card.

Tool Joint Compound

Gulf Tool Joint Compound, a protective-coating lubricant for drill pipe threads, used in shallow and moderate depths, contains special additives designed to increase tackiness and insure that a coating will remain on pipe after breaking sections. Introduced in Southwest area, prior field tests indicated anti-galling properties and resistance to water penetration. Brochure outlines performance characteristics. *Gulf Oil Corporation.*

Circle number (33) on reply card.

Logging-Drilling Analysis

Three-instrument well logging rental package which automatically records and compares by time six key drilling functions, detects and chromatographically analyzes gas shows and logs drilling time has been developed. Caddygraph combined a six-channel drilling recorder, gas detector-anaylzer, and an electro-mechanical log for securing drilling time data into this package. *Carrygraph, Inc.*

Circle number (34) on reply card.

INDUSTRY HONORS HOUSTON OIL EDITOR AND AUTHOR

James A. Clark, co-author of the book "Spindletop" and syndicated columnist of authentic historic tales of the oil patch, longtime oil writer, reporter and consultant to the petroleum industry, was given a testimonial dinner in Houston on March 17. Hosted by all segments of the industry, the dinner was called "The Petroleum Industry's Salute to Jim Clark." Michel T. Halbouty, Houston independent oilman, headed a 21-man committee which arranged and conducted the event. In addition to Clark's many personal friends in petroleum and the nation's press, special guests came from New York, Washington, and the West Coast.

When It Comes To . . .

REELS

Drillers and Producers Choose . . .

Mathey

Many Combinations of Sizes, Drives and Power

Call or Write for Further Information

Mathey Measuring Line Reels for bottom hole pressures, temperature surveys, deviation tests, calipering, paraffin cutting, sampling and many other wire line jobs. Mathey Reels are designed to meet your requirements of line speed, line pull, spool capacity and type of power. Special reels are engineered and manufactured to your specifications.

C. A. Mathey MACHINE WORKS, INC.

212 So Frankfort Tulsa Okla • Box 1159 • LUther 7 7311

RUNNING TOUR with MEN in the INDUSTRY

▸ **John J. Arps,** vice president of the British-American Oil Producing Company, was named Dallas' outstanding petroleum engineer for 1961 by the Dallas Society of Petroleum Engineers of AIME. **Lloyd E. Elkins,** production research director for the Pan American Petroleum Corporation in Tulsa, was appointed president-elect, pointing to the presidency in 1962. President for 1961 is **Earl M. Kipp,** special consultant on the staff of the director and vice president in charge of production-exploration for Standard Oil Co. (Calif.).

▸ **Mason L. Hill,** manager of exploration for Richfield Oil Corporation, will become the 45th president of the American Association of Petroleum Geologists.

G. R. Gray

L. A. Little

▸ API Citations for Service will be conferred on **George R. Gray,** Baroid Division, National Lead Co., Houston, and **Lloyd A. Little,** Lufkin Foundry and Machine Co., Lufkin, at the API's Southern District Meeting March 8 in Shreveport. Gray's award is in recognition of outstanding service since 1951 to oil well drilling fluids studies and technology. The award to Little is in recognition of his service to the API oil well production equipment standardization program.

▸ **Robert N. Bynum** was elected vice president of Parker Drilling Company.

▸ A new production division has been formed with the consolidation of Arkansas Fuel Oil Corporation into the Bartlesville-headquartered Cities Service Petroleum Company. **A. H. Weyland** will serve as division superintendent, with headquarters in Shreveport.

▸ **Kenneth R. Babcock** resigned from Well Testers Company and has formed his own well testing company under the name "Ken Babcock" with offices in Snyder, Texas.

▸ California Research Corporation announced that **Saleh A. Amba** has joined the La Habra Laboratory as a research engineer in the producing research.

▸ **George E. Farmer** was appointed chief engineer of Consolidated Oil and Gas, Inc., of Denver.

▸ New district drilling and production engineer in Lafayette, Louisiana, for Falcon Seaboard Drilling Company is **J. A. Couvillon,** formerly with Pan American Petroleum Corporation.

▸ **Robert L. Gollnick,** evaluation geologist, has opened consulting offices in Houston. For the past ten years Gollnick had been senior staff geologist with Ralph E. Davis Associates.

Mädan M. Singh, and **M .H. Harris** (per previously with the Ohio Oil Company), have joined the production engineering division of Gulf Research & Development Company.

▸ Helmerich & Payne Inc. announces three appointments: **Harrison L. Townes,** exploration manager; **Richard N. Knoblock,** chief engineer in production; and **Jay C. Tapp,** assistant to the president.

▸ Midland will be one of the four areas in Humble Oil & Refining Company's Southwest region. **James C. Posgate** will be manager of the Midland area; **R. C. Barbour,** production manager-Humble Division; **John L. Loftis Jr.,** regional exploration manager; and **J. C. Wilbourn,** regional marketing manager.

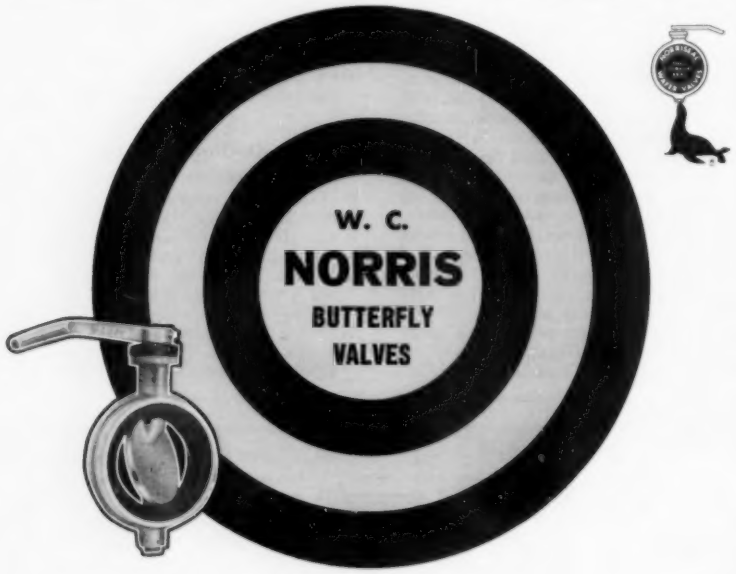
▸ Kern County Land Company has announced a number of personnel changes. **George W. Burgess** was named district manager-New Orleans; **Donald G. Cook,** district manager of exploration and development-Permian Basin; and **John S. Baker,** manager-Four Corners district.

▸ The Lion Oil Division of Monsanto Chemical Company moved all geologists located at Casper, Wyoming, and Durango, Colorado, to Denver on March 1. Denver will serve as the base for exploration activity throughout the Rocky Mountain region.

▸ **J. B. Fryer** has been named staff exploration manager of Mobil Oil Company's Midland exploration and producing division, and **John D. Howard,** drilling and production chief in the Denver exploration and producing division.

▸ North Star Oil Company has opened an exploration and production office in Midland, with **Robert J. McLellan,** consulting geologist, in charge of operations.

▸ Sunray Mid-Continent Oil Company announced that **A. E. Meissner** has been appointed production manager Western division in Denver, replacing **O. A. Graybeal,** who was named administrative assistant to R. E. Foss, vice president in charge of production.



Target

Versatility-Economy

Now you can reduce costs and simplify valve specifying by using the highly versatile and economical Norriseal Wafer Type Butterfly Valve. Designed for working pressures to 150 psi, the Norriseal Valve features removable and interchangeable rubber and metal seats . . . takes up less line space . . . can be easily and quickly removed for "on-the-spot" maintenance . . . is field repairable. The wide selection of trim available qualifies the Norriseal Valve for use in many oil field and industrial applications.

Write for prices and complete literature today!

BUY FROM YOUR NORRIS DISTRIBUTOR

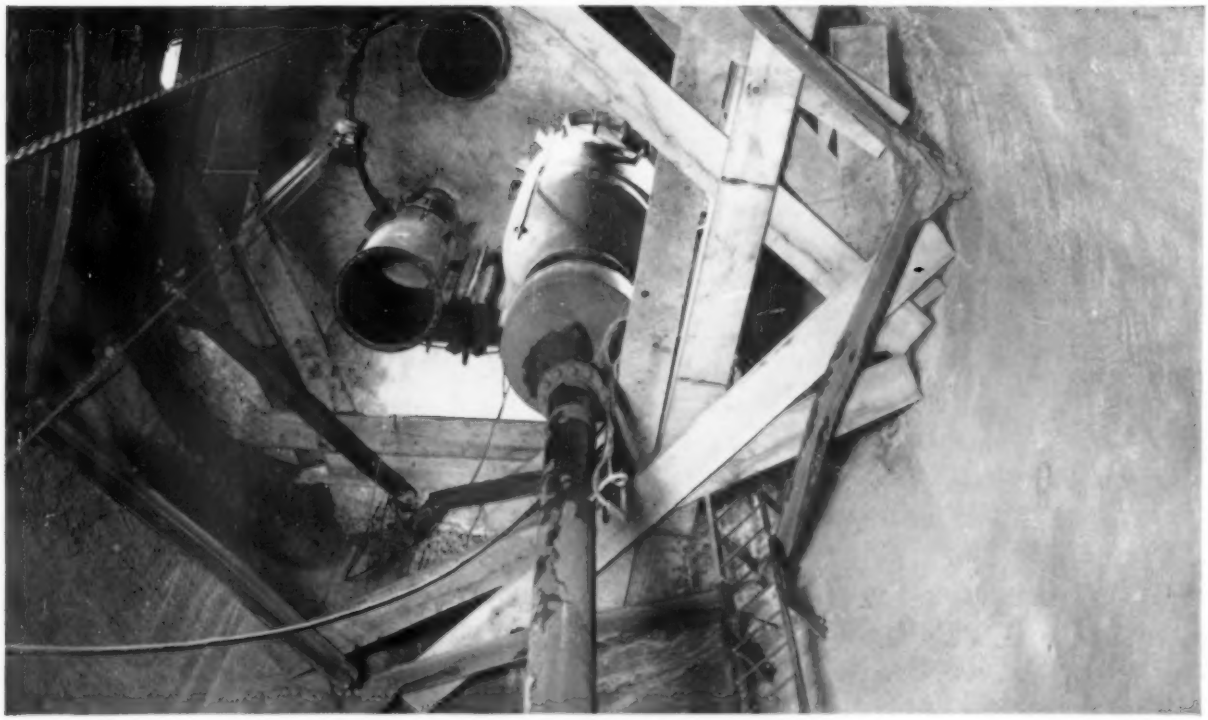
NORRIS QUALITY Butterfly Valves

W. C. NORRIS DIVISION
DOVER CORPORATION
P. O. BOX 1730 • TULSA, OKLA.

BRANCHES: Great Bend, Houston, Kilgore, Odessa, Wichita Falls, Salem, Casper, Farmington

Five years later:

No repairs needed on regenerator's refractory concrete lining



When this regenerator chamber was opened at the Canton (Ohio) refinery of the Ashland Oil & Refining Company after five years of service, the refractory concrete lining was in excellent condition. No replacement was needed. The smooth, jointless surface of the concrete, made with LUMNITE calcium-aluminate cement, required only minor patching. It resisted abrasion by catalyst and the penetration of gases.

In other refinery equipment (heaters, vapor separators, transfer lines, cyclones, stacks, breechings, etc.) refractory concretes made with LUMNITE cement can be designed to meet every operating condition. For extra convenience and economy, castables containing LUMNITE cement are available from leading manufacturers of refractories. These are packaged mixtures, requiring just water and mixing. For more information, write Universal Atlas Cement, 100 Park Avenue, New York 17, N. Y.

"USS," "Atlas," and "Lumnite" are registered trademarks

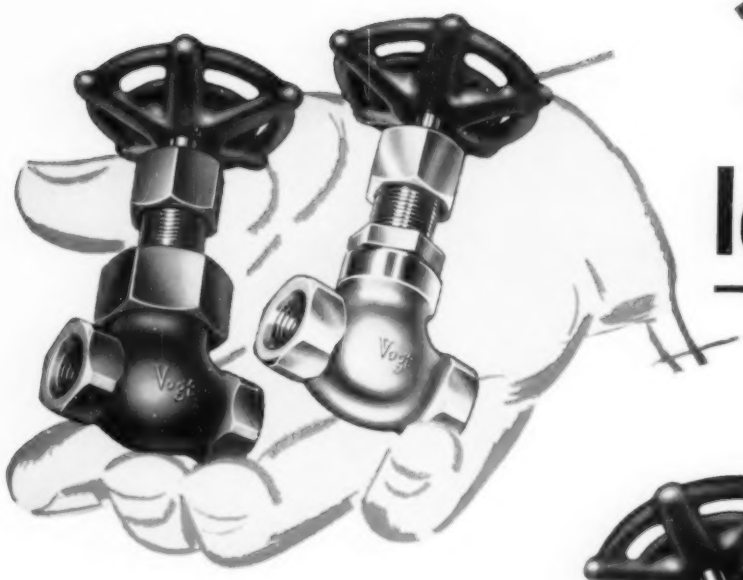
L-210

Universal Atlas Cement
Division of
United States Steel

Offices: Albany · Birmingham · Boston · Chicago · Dayton · Kansas City · Milwaukee · Minneapolis · New York · Philadelphia · Pittsburgh · St. Louis · Waco

New higher quality

New lower price



Enlarged production facilities combined with improved manufacturing techniques enable Vogt to pass on the effected savings to our customers.

Service proved — these valves have always been a standard of quality for meter and gauge line service. You no longer need to compromise for less because of price! Send for Folder GP-9 giving specifications and engineering data on both globe and angle types, forged from stainless or carbon steel for every meter and gauge line service.

Address Dept. 24A-FPC

METER & GAUGE LINE

Vogt

VALVES

HENRY VOGT MACHINE CO.
Louisville, Kentucky
SALES OFFICES: Camden, N. J., Charleston, W.Va., Chicago, Cleveland, Dallas, Los Angeles, New York, St. Louis.

construction briefs

▸ **Ohio Oil** will make its debut as a supplier to the petrochemical industry with completion of a multi-million dollar expansion program at the Detroit refinery of Aurora Gasoline Co., a wholly-owned subsidiary. This is part of an agreement to provide Dow Chemical Co. with about 20,000,000 gal of benzene-toluene annually.

Dow will build a processing unit at its Bay City, Michigan petrochemicals plant to convert the benzene-toluene mixture to benzene for use as a raw material in its Bay City and Midland chemical plants.

▸ **National Distillers** will construct a 60,000,000-lb-per-year plant at Houston to produce high density polyethylene plastic under license from Phillips Petroleum Co.

▸ **Construction of facilities** to produce benzene and other aromatics at the Texas City refinery of Plymouth Oil's Republic division will mark Plymouth's entry into the production of petrochemicals. Total expenditure will be approximately $2,500,000. Procon, Inc., has construction contract.

▸ **Engineering and construction contract** for United Carbon's new 64,000,000-lb carbon black plant 85 miles north of Los Angeles has been awarded to Lummus Co., Houston.

▸ **A 12,000-bbl-per-day hydrotreater** to remove sulfur from a kerosine feedstock is under construction at Texaco Inc.'s Port Arthur, Texas, refinery. Fluor Corp., Ltd., has contract for design, engineering, purchasing, and construction.

▸ **Dominion Tar and Chemical Co., Ltd.,** will build a 22,000,000-lb-per-year plant at Toronto to produce phthalic anhydride via a fluid bed process. Engineering and construction will be by Canadian Badger Co., Ltd. Toronto.

▸ **El Paso Natural Gas Co.** will build an ethane recovery unit near Jal, New Mexico, to supply raw materials for refining-petrochemical operations at Odessa, Texas. Plant will be able to process 650 MMcf of natural gas daily and recover 5600 bbl of ethane, 7000 bbl of propane and 1320 bbl of butane.

▸ **A $7,000,000 plant** with initial capacity of 10,000,000 lb of isocyanate is being built in Linden, New Jersey, by Nopco Chemical Co.

▸ **Crown Central Petroleum Corp.** has started construction on a Udex unit at its Houston Ship Channel refinery which will produce high grade benzene, xylenes, and toluene for use by other chemical manufacturers.

▸ **Dow Chemical** is building a second polyolefin plant at Plaquemine, Louisiana, capable of producing medium and high density polyethylene and ethylene copolymers as well as polypropylene.

▸ **Oxo Chemical Co.,** a new company owned 50-50 by Amoco Chemicals and Pittsburgh Chemical, will build a multimillion pound per year iso-octyl and decyl alcohol plant at Haverhill, Ohio.

▸ **A $1,000,000 expansion** is underway at the Oak Point, Louisiana, plant of Oronite division, California Chemical Co., which will increase production of a new lubricating oil additive.

▸ **A gas processing plant** will be built near McGregor, North Dakota, to process gas from more than 100 oil wells in the North Tioga and McGregor fields. Hunt Oil Co., Dallas, Texas, will operate the plant.

▸ **Fluor Corp., Ltd.,** has contract exceeding $1,000,000 for engineering and procurement for a 6659-bbl-per-calendar-day crude unit and other facilities to be erected at Conchan, Peru, for Refineria Conchan-California, SA. Refinery is principally owned by Peruvian interests and partly by Standard Oil Co. of California.

▸ **Shell Oil Co.** has announced plans to build Denmark's largest oil refinery, a 2,000,000-tons-per-year plant to cost $30,000,000.

▸ **Construction** is underway on a $11,200,000 refinery at Zerka, Jordan, to handle some 330,000 tons of petroleum annually.

▸ **Refineria Panama, SA,** 50%-owned by a Conoco subsidiary, is lining up financing to construct an oil refinery in Panama.

Rooftop view shows Texas Eastman's new polypropylene facility at Longview, Texas, which by mid-1961 will have an annual production capacity of 20,000,000 lb.

▸ **A $30,800,000** expansion program is planned at the Antwerp refinery of Societe Industrielle Belge des Petroles, jointly owned by British Petroleum and Petrofina. Capacity will be boosted from 80,000 to about 160,000 bbl per day with installation of 100,000-bbl-per-day crude distillation unit, 9000-bbl-per-day catalytic reformer, 10,000-bbl-per-day Hydrofiner, and 60-tons-per-day sulfur recovery plant. Catalytic cracking plant capacity is being increased from 12,000 to about 15,000 bbl per day.

▸ **Contract for Standard-Vacuum's second Australian refinery,** a 37,800-bbl-a-day fuel products and solvents plant to be built near Adelaide, has been awarded to M. W. Kellogg.

▸ **Agip Mineria of Milan, Italy,** will construct a $23,800,000 refinery in Ghana to process about 1,000,000 tons annually.

▸ **Yugoslav government** plans a 23,000-bbl-per-day refinery at Pancevo, near Belgrade.

▸ **Deutsche Shell** will build a refinery with initial capacity of at least 40,000 bbl per day near Ingolstadt in Bavaria.

▸ **Petroleo Brasileiro, SA,** has been authorized by the Brazilian government to construct refineries at Porto Alegre and Belo Horizonte.

▸ **Esso Petroleum** will construct a 30,000-long-ton butyl rubber plant, to cost $12,000,000, at its Fawley, England, refinery.

Instrumentation

R. E. HUGHES

RIGID JUSTIFICATION for instruments must be made on the merits of the individual problems involved in each specific application in the refining, natural gasoline, and petrochemical segments of the Hydrocarbon Process Industry. Generalities and trends are helpful at the start to indicate direction, but the details are an individual matter.

A person who requires frequent transportation may consider walking, getting a horse, taking a bus or train, or buying a car. Statistics show that the trend is to buy a car, so the decision is usually not whether to buy a car, but rather what kind of car to buy and how much to pay for it. A Cadillac is fine for highway travel and for impressing friends and customers, but for mountain roads, a Jeep is better. Both cars have possible economic and practical advantage, but the choice is an individual matter.

Any attempt to analyze whether or not instruments make money must include some basic assumptions. We must agree that the primary reason for any company to be in business is to make a profit. A company that does not make a profit can not remain in business. If instruments are to be considered as money makers, they must increase company profits, and they must make more profit for the company than could be made by reasonable alternate methods.

Let us consider first a very small segment of the Hydrocarbon Process Industry in which one operator supervises the operation of one portion of a process, and that portion is controlled by 24 instruments. If we consider that the wages of one operator approximate $6000 a year, and that the average cost per instrument installed is $500, then for the first year one operator costs $6000, and the instruments cost $12,000.

But it requires about four operators to cover the 24-hour day 7 days a week, so that one daily shift of operators for one year costs $24,000. For the first six months then, the operators cost $12,000, and the instruments cost $12,000. In the second six months the operators cost another $12,000, but the instruments are already there. From here on the cost of the operators continues, but the cost of the instruments is completed.

From these simple approximations one might be tempted to conclude that it would be possible to replace the $24,000 yearly operator expense with $12,000 worth of instruments and save the $24,000 yearly operators' wages after the first six months. Such a conclusion would be entirely wrong.

The correct conclusion in this example is that $12,000 worth of instruments are required to enable the $24,000 operators to operate this portion of the process efficiently. The operator cannot operate without the instruments, and the instruments cannot operate without the operator. Although it is probable that two or three operators might operate the process with fewer instruments, it is not probable that any number of operators could operate effectively without instruments nor that any number of instruments could operate effectively without the help of at least part of the operator's time. Many other items such as overhead, supervision, maintenance and repair of the instruments, etc., must be taken into consideration to determine the value of instruments in the detailed analysis of any specific problem.

R. E. HUGHES, special editor for *Petro/Chem Engineer's* symposium on Process Instrumentation, is senior instrument engineer for Shell Chemical Company at Houston, and a past president of the Houston section, Instrument Society of America.

From 1949 through 1960 he served as instrument engineer, job engineer, and senior engineer of Shell Chemical, covering design, purchase, installation, and maintenance of plant instruments.

At the present time he is primarily concerned with instructing technical personnel in the application of instruments to process control to achieve improved plant operating efficiency. He has prepared an instruments handbook as a text for instruction in the Shell plant.

Hughes is keenly interested in making technical data on process instrumentation available to the general design engineer. He is author of the technical paper "Metering Interplant Flows" published in the May 1956 *Instrument Society of America Journal.*

. . . an efficient money-maker

To provide a basis for consideration of various alternate methods, and to determine the general trends, a look at some national business statistics is worthwhile.

Since 1948, when annual corporate profits after taxes reached about $23 billion, such profits have remained quite static. The maximum was $24 billion in 1950, and the minimum was $17 billion in 1949. In 1959 profits again approached $24 billion, and they dropped off again in 1960, but they have remained relatively stable at an average of about $20 billion. For 1960 this approximates $400 yearly per worker. During the same period of time, corporate taxes have approximately equaled corporate profits.

During this period, labor income before taxes increased almost continuously from about $137 billion in 1948 to $280 billion in 1960. The latter figure averages about $5000 annually per worker. From 1948 to 1960 national income has increased from $220 billion to over $400 billion, gross national product has increased from $260 billion to $500 billion; the industrial production index has increased from 105 to 145%; the consumer price index increased from 105 to 127%; total non-agricultural wage and salary workers increased from 44 million to 53 million, and the labor force increased from 62 million to 73 million. Our exploding population increased from 149 million to 177 million, or less than 19%.

In general approximation then, during the past 12 years corporate profits after taxes have remained constant, while labor income, national income, and gross national product have doubled. Meanwhile, industrial production, total wage and salary workers, and the labor force have increased by less than one half.

From these statistics we can draw a lot of conclusions, some right, some wrong, some economic, some moralistic, and some practical. Although the statistics do not so indicate, many people conclude that instrumentation or mechanization causes unemployment. There are a number of reports and studies available which prove the contrary. Instrumentation or mechanization actually increases employment and improves the over-all standard of living. One man with a wheelbarrow can easily move more sand than 10 men without a wheelbarrow. But the use of a wheelbarrow makes building more efficient. More people can afford to build, and more men with more wheelbarrows are required to meet the demand for buildings. This means more employment.

However, this is not intended as either an economic or a moralistic treatise. I do not intend to imply that these conditions are either moral or immoral, fair or unfair, nor that they mean the country is heading for a depression or a boom. I am simply stating published facts. These are the conditions that prevail and you are entitled to your own conclusions.

However, there is one point in these statistics that is obvious to corporate management: Corporate profits are not increasing. Corporate management is hired to increase corporate profits, and it has not succeeded in doing so. What are they doing about it? What can they do about it? Here again the national statistics will give us a general indication of one answer.

In 1948 gross private domestic investment was at the rate of $41 billion per year, or $935 per year for each employee. In 1960 it was $75 billion per year, or $1400

At Shell he has set up and put into operation a system of instrument records covering all existing major instruments. Additions and changes automatically are made to the records as new instruments are added, removed, relocated, or modified. These records also serve as a basis for systematized preventive maintenance of important plant instruments.

Hughes holds a BS in economics from the University of Houston, which may seem to be a peculiar background for anyone working in a technical profession. However, it has considerable merit. Hughes' background in both education and experience is probably broader than that of most technical personnel, and this accounts for his choice of degree.

After three years of chemistry at the University of California at Berkeley, Hughes went to work in 1935. Jobs were not plentiful, but Hughes was able to work quite steadily through the depression years. He obtained experience as a painter, pipefitter, welder, gas equipment serviceman, instrument mechanic, and general maintenance foreman, and also traveled over most of the country.

He learned quickly that the only way to get a job and hold it is to be able to make more money for the boss than someone else can make for him.

When Hughes joined the Hydrocarbon Processing Industry in 1942 he selected instrumentation as the field most likely to make money for the company, and accordingly for him. He took night courses in radio, electrical engineering, and chemical engineering to learn the technical details of instrumentation.

Later on he realized his lack of information in accounting and corporate finance, observing that it is impossible to apply money-making procedures and equipment without an understanding of management procedures and financial policy. So he entered college at night again and got his degree in economics in 1954.

Hughes has discovered that the basic rules of business management, accounting cost controls, and instrumentation are identical. The only differences are in terminology, time constants, methods of communication, and hardware.

per year per employee. This is more than three times what the average employee earns for the company. New construction in 1948 was $18 billion, or $410 per year per employee, but in 1960 it was $40 billion or $760 per year per employee.

These figures of investment per employee are not additive, and they do not indicate the total investment per employee. They only indicate the annual increase or additions to investment per employee. The figures do show that the rate of investment per employee was more than 50% greater in 1960 than in 1948.

The industrial production index for instruments and related products increased from 105 in 1948 to 200 in 1960. These figures indicate that total private investment, new construction, and instrument production all approximately doubled from 1948 to 1960. But from 1955 to 1960 instrument production increased by 33%, while new construction and total investment increased only about 20%.

In 1948 the average refinery or chemical plant put about 3 to 5% of its capital cost into instruments. In 1960 the average is from 7 to 10%.

When one stops to consider that about 40% of a plant's expenses go for wages and salaries, that in two or three years the wage and salary expenses will equal the capital cost of the plant, and that less than 10% of the cost of the plant is instruments, it is easy to see that a very small improvement in quality or productivity will easily justify the cost of additional instrumentation.

These statistics are general. They do not prove that you or any one else can use instruments to advantage, nor that you cannot. They show that the country as a whole is investing in instruments and related products at a more rapid rate than it is investing in other capital equipment. The same is true in many other countries.

The problem of determining whether you can use instruments to advantage, how you should use them, and what types you should use is much more complex. It requires a detailed analysis of your specific operation and of the various specific costs of that operation.

If you have an old fashioned kitchen stove that has a hand-operated gas adjustment on the oven, you can buy an oven temperature controller for about $50, install it, and control your oven temperature automatically. It is probably worth $50 to you for the convenience. But if you put an air conditioner in the room with the stove, you have a problem. Would you prefer to pay the extra operating costs of the air conditioner to overcome the heat put out by the oven? Or would you prefer to pay for the installation of a vent on the stove to take the extra heat away?

This is a small problem to your budget because it represents only a few dollars. But the correct solution on a similar problem on a large scale in an industrial plant may mean the difference between a profit or a loss from operation, and it becomes a serious problem when the stove is a line of several boilers that must furnish steam on demand to a series of steam heated distillation columns that must maintain constant temperature in a sudden rainstorm.

Problems in instrumentation must be solved by the same methods that are used in solution of any other problem. The problem or objective must be stated clearly to determine what is desired. All pertinent information that will or may affect the objective must be assembled, studied, and corrected. Several methods of approach will have to be considered and analyzed until the best solution to achieve the objective has been found. The instrument engineer studies the process, analyzes the problem, and proposes a solution. But the manager makes the decision on which solution is to be used.

The manager is also the expert in all categories of the plant, and he must make his own decisions. He must be right, and he must be modern in his thinking.

For many years it has been common practice to calculate the dimensions of a distillation column to obtain the quality and quantity of product that is required. The rules are clearly spelled out in chemical engineering textbooks, and almost any chemical engineer can calculate a column. When it is discovered that a certain distillation column will make specification product only half of the time, and re-runs of the off-specification product are required frequently, then there is good justification for making some changes. A study of the problem will often reveal that the operating conditions are different from those originally used to design the distillation column.

The obvious solution to the problem is to design a new column based on the new operating conditions. This solution is obvious because this is what process engineers have been trained to do. The answer is in the textbook, and the payout for the expenditure can be proved by the textbook. A new column installed may cost $200,000 and could be justified. If an extention to the column is calculated to be adequate, it may cost only $100,000. In either instance the justification could be clearly shown.

However, it is not uncommon that the same results could be obtained simply by closer control of the existing column, and the instruments to obtain the required result and product quality could be obtained at a fraction of the cost. If the problem is caused by varying feed composition, perhaps a feed composition analyzer with feed-forward controls could be applied, and the cost would seldom exceed $25,000. Probably the worst condition would require a product analyzer with provisions for recycle immediately of off-specification product, and the cost of this should seldom exceed $25,000. It is always possible that multiple temperature or pressure controls or perhaps simply re-application of existing controls could accomplish the results with only a few thousand dollars of expense.

But there are no clear-cut formulas to prove what these instruments will do. The answers are not in the textbooks. The justification is not clear-cut nor easily proved by formulas that have been used for years. Very close estimates can be made in advance, but they must be classed as estimates because the formulas are not in the textbooks. Nevertheless, many thoughtful forward-looking managers have proved that instruments, applied with care and study by experienced process control personnel, will pay for themselves much faster than conventional process equipment.

The statistics show that the use of instruments is increasing rapidly. But the choice of a solution to each specific problem is still an individual decision. ★ ★ ★

Instrumentation trends in HPI

A. H. SCHUTTE

ABOUT THE AUTHOR

A. H. Schutte is a senior staff member in the engineering division of Arthur D. Little, Inc., at Cambridge, Massachusetts, and is a member of the *Petro/Chem Engineer* editorial advisory council. He formerly was with The Lummus Company for 25 years, leaving the post of vice president in charge of the New York division to join Little. His engineering experience also includes service with Standard Oil Company of New Jersey (later Standard Vacuum Oil Company) and The M. W. Kellogg Company. Schutte, a registered professional engineer in the State of New York, holds an AB in chemistry and physics from Dartmouth College and an MS in chemical engineering from Massachusetts Institute of Technology.

CONTROL METHODS in the Hydrocarbon Process Industries have advanced rapidly from the days of glass-stem thermometers, pressure gages, and pump-stroke counters.

Progressing from locally mounted indicators to the centralized control room, we passed through a period of impracticality similar to that of the first multi-engined airplane cockpits. In the days before the graphic panel we had control rooms completely surrounded by 75 to 100 ft of control board, mounting the old-fashioned large pneumatic instruments.

It was impossible to obtain a quick picture of what was actually going on in the process equipment. The observer had to remember things like "TRC-31 controls the heat input to reboiler EA-203 on fractionating column D-7."

With the advent of the graphic panel, the operator could walk up to a silhouette of Column D-7 on the board, observe instantly what was going on in the reboiler circuit, and note at a glance that this was being controlled by TRC-31.

These gains had their attendant difficulties, however. Miniature instruments were required, and the early ones were awkward to use, difficult to read, and difficult to service. Soon electronic controllers replaced the miniature pneumatic ones in some plants. The electronic instruments had far less time-lag and this was really necessary in certain applications as, for instance, on a fluid catalytic unit where catalyst flows of 15 tons per minute are common.

First generation electronic instruments were highly unreliable and difficult to maintain. Anyone who has seen a large production unit thrown into a crash shutdown because of the failure of some electrical component can appreciate the frustrations of this period. It was something like watching a television program and having horizontal-hold go off just as the home team ran for a touchdown. Even today, electronic instruments are unreliable unless trained technicians are available 24 hours a day to service and repair them, and unless the atmosphere in the control house is properly air-conditioned.

Air conditioning is no longer a luxury for the operating personnel but in many climates is an absolute necessity for reliable instrument performance. Until the second generation of electronic instruments has proven itself, the use of this type should be avoided in any location where factory-trained servicemen are not available on short notice.

Modern pneumatic control instruments have been refined and improved so that they are completely competitive with the electronic type, except for the rare case where very rapid response is required. The pneumatic controller has the edge on simplicity and ease of maintenance. It has the disadvantage of not fitting in easily with automatic data logging systems.

Automatic data logging has been a controversial subject. Desire for the most up-to-date has probably influenced some companies to install these systems where there was really no other justification. One real advantage of data logging on complex plants is that one can design the system to signal and type out any reading which falls above or below preset limits. This offers a perfect monitoring of the control board and is actually more useful than the automatic logging feature.

Once the system is designed for monitoring, little additional expense is required for complete data logging. When these systems have been developed to the point of high reliability they can become the sensing and scanning elements of an advanced computer-controller which will make the non-routine decisions for the operator.

Plants have become so complex that even with graphic panels and a central control console the operator finds himself pressed with too much information to be able to detect instantly which is the important variation in operating conditions and which is merely routine indication and recording of a normal reading. The operator needs to have information of immediate importance stand out and still be able to check the other process conditions at will.

Modern process units are so highly instrumented that the operator is hardput to bring the unit down safely when something really goes wrong. In the case of power failure or an instrument air failure, he is in the position of a captain with a one-man crew trying to handle a four-masted schooner in a sudden storm.

A large HPI plant may process raw materials worth $100,000 per day. This would seem to be a good reason for using computer-type controllers. These should be capable of holding process variables closer to the ideal optimum than can be done by manually resetting conventional control systems.

The Hydrocarbon Process Industries will probably be rather slow to adopt computer-controllers for several reasons: one is that the limited reliability of the present automatic data-logging systems will make industry reluctant to tie this in with the important control circuits; another reason is that the time response of most large scale process plants is slow enough to permit manual resetting of conventional control systems so as to obtain pretty close to optimum conditions. The computer would then be used outside the control room to determine optimum performance for a wide range of process variables, feed stocks, and product characteristics.

The operator is a pretty sophisticated instrument and is usually quite capable of making non-routine decisions. He is an expensive instrument since one operator around the clock in American industry will cost $20,000 to $25,000 per year. In foreign countries where wage scales are lower than in the United States, we would expect the replacement of the operator by the computer-controller to be even less attractive.

Safety is another factor. The computer-controller cannot replace an operator who is needed to assure the safe operation of the plant in the unusual emergency. In many cases today's instrumentation has already reduced the operating staff to the minimum safe number of people.

The use of computer-controllers must be considered on a case by case basis, asking the questions:

> "Is the process adequately controllable by conventional systems plus an operator?"
>
> "Is there economic justification for the computer-controller through increased yields or more uniform product?"
>
> "Can the operating crew be reduced without sacrifice in safety?"

In cases where the computer-controller is justified, it would seem that the new adaptive control systems would be justified.

This is a method whereby the system characteristics are changed continuously, according to the experience of the process unit, to approach a built-in standard of performance continuously calculated by a computer analogue of the system. Adaptive control systems are new, but they can handle otherwise impossible control problems. Since they were developed for rapidly reacting systems like supersonic aircraft, it will be interesting to see whether their use will be justified in the control of process equipment.

Actually, the development of computer-control systems is way ahead of the improvements in sensing elements. Little progress has been made in sensing response and accuracy since the introduction of force-balance transducers some years ago. (Automatic analyzers are an exception to this.) Temperature sensing is particularly sluggish, due to the heat capacity damping effect of the thermocouple and the thermocouple well. A real breakthrough is required before rapid temperature changes can be measured. The controllers are already available, but rapid response is useless when coupled to a basically slow sensing element.

The key to the performance of a process plant usually lies in running-stream analyses. In the old system the operator took a sample periodically, sent it to the laboratory for analysis and readjusted his plant to correct any deviations. With analyses run by wet chemistry, the time lag from sample to adjustment was frequently a matter of hours.

Shortly before World War II infra-red analyzers and controllers became available through developments in Germany and the United States. These instruments gave an instant analysis of a critical stream but were troublesome when installed in an operating plant and subjected to vibration, weather and corrosive conditions. Skilled technicians were required to service them, and the diagnosis of their ills required the services of the factory representative.

About 1955, chromatography became available for plant-stream analysis and control. Both solid-gas and liquid-solid systems were rapidly developed and offered trouble-free low cost analyses of multi-component streams. In addition, they could be installed to obtain analyses on many streams with a single instrument. Received with grudging doubt by the operators at first, they are now a basic and extremely important tool in plant control. The infra-red analyzer is still more rapid for basic reasons, but the chromatographs are being speeded up by the use of new techniques such as capillary tubes.

Summarizing, it appears that the control house of the future will employ "in the line" computer-controllers in a few special instances. Chromatographic analysis and control instruments will be widely used. The operator will still be at his control console for some time to come to make the non-routine decisions. The instrument system designer will grudgingly accept his presence and will endeavor to design the indicating, recording, data logging, and memory systems so as to make his job as easy as possible. Pneumatic instruments will still be used, especially in locations where highly trained service men are not on ready call. ★ ★ ★

SAMA

. . . an organization that works for you

INSTRUMENTS AND CONTROLS play a vital role in the Hydrocarbon Process Industry today, making possible control of processes with phenomenal degrees of accuracy and economy of manual operation.

In many instances processes could not have come into being without automatic controls.

Little wonder the rate of expenditures for meters and controls has increased twice as fast in the last 15 years as that for other capital goods. A study of capital expenditures in the Hydrocarbon Process Industry indicates more than $125,000,000 will be spent world-wide on instrumentation during 1961.

The need for establishing standards for instruments and controls was met in 1944 with the formation of the Recorder-Controller section of the Scientific Apparatus Makers Association, a trade association now made up of 23 leading companies engaged in manufacture of process control instruments. This cooperative organization serves its member companies through the distribution of standards, trade reports, statistics, interpretation of government regulations, and work dealing with economic and marketing surveys. Official SAMA representatives of member companies are pictured with this article.

The organization's efforts have resulted in the development of an awareness which makes for standards of quality and operation of utmost importance to both the industry and the public. Standardization projects enable members to reduce production costs, lower inventory carrying charges, obtain component parts more readily, and offer customers better service.

The Recorder-Controller section is headed by an 8-man executive committee composed of presidents, executive vice presidents, or vice presidents and general managers of member companies. Each member is elected for a 1-year term, and is eligible to serve for three terms. It is a policy to keep the executive committee personnel representative of top management from large, medium, and small companies, and by geographical location.

The chairman is chosen from among the executive committee members, is elected for a 1-year term, and is eligible for two terms. The present executive committee chairman is William H. Faeth, president of The Bristol Company.

The Recorder-Controller section is divided into four major groups . . . engineering executives, financial executives, industrial relations executives, and sales executives . . . each headed by a committee which holds at least two meetings a year.

At the present time there are 33 active, working committees on which 183 executives of member companies are serving.

P. S. DICKEY
President
Bailey Meter Company

E. H. BRADLEY
President
B-I-F Industries

W. J. McDONOUGH
General Sales Manager
Blaw-Knox Company
Copes-Vulcan Division

W. H. FAETH
President
The Bristol Company

The engineering executives' group is the most active group, carrying on all technical and standardization activities. Under it, some 23 subcommittees have worked and are working in the development of standards.

To date, nine permanent SAMA standards have been developed, five tentative standards are moving toward adoption as permanent standards, and five more are in the proposed standard stage. Other subcommittees are working on projects that may eventually develop into proposed standards.

Now in effect are SAMA industry standards relating to mechanical and electric chart drive speeds of circular charts, air pressures for pneumatic controllers and transmission systems, bimetallic thermometers, resistance thermometers, filled system thermometers, glass stem industrial thermometers, thermocouple thermometers (pyrometers), temperature-emf relation for iron-constantan thermocouples, and mechanical chart drives.

Currently in the tentative stage are standards pertaining to accuracy and sensitivity terminology as applied to industrial instruments, locks and keys for instrument cases, panel cut-out dimensions, bimetallic thermometers, and liquid-in-glass industrial thermometers. The latter two are revisions of present standards and if adopted will replace the existing standards.

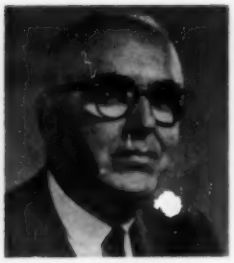
SAMA standards are adopted in the public interest and are designed to eliminate misunderstandings between the manufacturer and the purchaser and assist the purchaser in selecting and obtaining without delay the proper product for his particular need. However, existence of a SAMA standard does not in any respect preclude any member or non-member from manufacturing or selling products not conforming with the standard.

In areas where standardization seems desirable, engineering subcommittees have conducted surveys to determine practices in which each company engages.

Liaison representatives to many engi-

W. L. APPLEGATE
Division Manager
Burgess-Manning Co.
Penn Instruments Div.

I. R. SCHWARTZ
Marketing Manager
Crane Co.
Swartwout Division



R. A. SCHLEGEL
Vice President and
General Manager
Daystrom, Incorporated
Weston Instruments Div.

B. H. BRISTOL
President
The Foxboro Company

H. J. VELTEN
President
GPE Controls, Inc.

B. L. JOHNSON
President and
General Manager
General Regulator Corp.

M. J. BOBO
Vice President
Hagan Chemicals &
Controls, Inc.

P. A. SPRAGUE
President
The Hays Corporation

I. M. STEIN
President
Leeds & Northrup Co.

neering societies and trade associations keep the engineering group posted on activities of these organizations in the area of instrumentation and control. This liaison cooperation has proved most useful in eliminating projects which were almost identical or at cross purposes, and in assistance to each other in areas of mutual interest and activity.

How standards are adopted

A proposed tentative standard that has been developed by an engineering subcommittee is first submitted to the standards committee, which checks the new standard for format (SAMA formats follow closely those of the American Standards Association), and then is submitted to legal counsel for examination and approval.

It then is submitted for discussion to the engineering executives and is voted upon by the engineering representatives, sales executives, executive representatives of member companies, and the section executive committee.

At this point a proposed tentative standard becomes a tentative standard for a 2-year period, at the end of which time it is reviewed. In the meantime it has been circulated to interested parties such as other SAMA sections, users, technical societies, and trade journals.

If after review no revisions are made, the standard is voted upon again by the engineering, sales, and executive representatives and executive committee. If approved, it is forwarded to the SAMA board of directors with the request that it be approved as a permanent SAMA industry standard.

For a standard to be approved, votes must be cast by at least 50% of member company representatives, and affirmative votes must be received from at least 75% of those voting.

At times one or two companies have voted in the negative, and even though 75% affirmative votes have been received, subsequent procedure has been delayed to allow time for the company that voted in the negative to meet with the subcommittee that developed the standard in an effort to resolve the differences.

Up to now these difficulties have been resolved, and the standards go out with the full backing of all member companies. Thus they carry more weight and dignity with those outside of the instruments and controls industry who may be using them or referring to them.

Sometimes, when a standard is submitted to the engineering executives, sales executives, or executive representatives for approval, it may be sent back to the subcommittee for further study before proceeding to the next step.

In one instance a standard, when submitted for executive representatives' ballots, was returned to the subcommittee that developed it for further study. This was in October 1953. After numerous meetings and correspondence it was finally issued as a tentative standard in December 1955. During this time 17 different comments, actions, etc., were taken in connection with the standard. Each step was carefully recorded for future reference.

Every effort is made to assure that all information leaving the section office is as correct as it is humanly possible to make it; proofreading and checking are among the most important parts of office routine. The same procedures are used meticulously on surveys, questionnaires, tabulations, and summaries.

Engineering subcommittees. The following subcommittees of the engineering executives' group are now active in the development of standards:

- Bulb and well committee
- Air supply pressure committee
- Chart drive standardization committee
- Accuracy and sensitivity terminology committee
- Thermocouple calibration curve committee
- Standards committee
- Case standardization committee and subcommittee
- Joint committee on instrumentation and control for steam generating units (joint committee of Recorder-Controller section, SAMA, and American Boiler Manufacturers Association)
- Electric transmission and control

F. J. MURPHY
Assistant General Sales Manager
Gauge & Instrument Div.
Manning, Maxwell & Moore, Inc.

E. A. BIANCHI
General Manager
Mason-Neilan Division of Worthington Corporation

J. S. LOCKE
Vice President and General Manager
Minneapolis-Honeywell Regulator Company
Brown Instruments Div.

B. PALMER
President
Palmer Thermometers, Inc.

C. UNRUH
General Sales Manager
Robertshaw-Fulton Controls Company
Aeronautical and Instrument Division

signal standardization committee
- Controller markings committee
- Systems engineering committee and subcommittees
- Computer committee.

The thermocouple calibration curve subcommittee, appointed in 1948, succeeded in a task that had met with failure on a number of previous occasions prior to the organization of the Recorder-Controller section. This had to do with an iron-constantan curve, RP 1080, established and adopted by the National Bureau of Standards 15 or more years previously which had proved impractical for instrument manufacturers. The SAMA subcommittee, working in cooperation with the National Bureau of Standards, was able to establish a new curve which was approved and is now a permanent SAMA industry standard.

Work of the joint committee on instrumentation and control for steam generating units has resulted in the publication of "General Recommendations for Location of Instrument & Control Equipment Connections for Power Boilers." This was revised in 1960 by a new joint committee of the two organizations known as the joint committee on instrumentation and control connections for power boilers.

The financial executives' group plans and carries out programs of interest to the treasurers and controllers of member companies.

The industrial relations executives' group studies and surveys subjects of interest to personnel and industrial relations directors.

The sales executives' group is concerned with current economic trends, both within the industry and in the general economy. Under it are several subcommittees, including standing committees on historical statistics. These committees receive all suggestions from the group to improve, revise, and keep up to date the historical statistical reporting procedures used by each member in reporting to the section's statistical agency. The objective is to make the section's historical statistics more useful and of real value to member companies.

The Recorder-Controller section has an historical statistical program that is rather elaborate. All member companies report quarterly to the confidential statistical agency their total dollar sales and number of units sold on types of instruments which are listed in 25 different categories. They also report total dollar sales and total units of all instruments to various industries, including the Hydrocarbon Process Industry. Companies also engaged in the combustion control field report their historical sales figures quarterly.

Other historical statistics cover bi-weekly order placements, which indicate a trend of total order placements. Each company receives tabulated reports from the statistical agency covering the products on which they report. Companies also receive bi-weekly order placement totals as well as industry totals.

Surveys are one of the most important services rendered by the section office. Format is developed in cooperation with the various committees. Experience has shown that the simpler the format, the faster replies will be received and the more companies will participate. Surveys are submitted to each member in duplicate so the members can retain a file copy. Included on each questionnaire is a place where the member can indicate disinterest in the particular survey. If the member has no interest in the subject matter, he merely checks the "disinterest statement" and returns the questionnaire, thus eliminating need for follow-up letters.

One of the most important aspects of the surveys is the matter of evaluating the information received. It is often necessary to set up the information in the order of greatest and lowest percentages, etc. Where a reply seems out of line, it is necessary to contact the individual member to request that he check his reply. By checking the answers against the "norm" or average of other members, it is possible to determine that a reply may be out of line, and by contacting the member, the correct information is obtained.

All questionnaires are handled on a strictly confidential basis, with the replies of individual members indicated only by key letters. In the letters sent to each company, the company's own key letter is indicated. ★ ★ ★

T. E. BELL
General Sales Manager
Republic Flow Meters Company

R. L. WEHRLI
Vice President
Robertshaw-Fulton Controls Company

H. C. MUELLER
President
The Powers Regulator Company

R. E. OLSON
President
Taylor Instrument Co.

Instrument gadgeteering . . .

Sound practice or waste of time?

CHARLES R. MILLER, *Instrument Foreman, United Rubber & Chemical Company, Baytown, Texas*

GADGETEERING has had a wide range of meaning in the instrument field. It has been used both with complimentary and derogatory connotations. *Is gadgeteering necessary and productive or is it doodling and day dreaming?*

Webster's dictionary defines *gadget* as "any ingenious mechanical contrivance or device." Grant the gadgeteer experience, information, and imagination. The reference then is correct, and the inference is incorrect.

There are many cases of gadgeteering. To sum them all up would be to say gadgeteering is any departure from standard application or engineering. A few examples

- Using an instrument or instruments in other than the design application.
- External revisions for maintenance convenience
- Revision of the internals.
- Development of a new instrument and application and many others.

Justifications for gadgeteering are many, but most are economic. Time can be a justification in cases where the need cannot wait for new equipment delivery. But again this could be economic too.

In the intricate processes of many modern hydrocarbon processing plants there are many instruments needed that are not now being manufactured. The available market may not be attractive to an instrument manufacturer. Research may be necessary, alone or in cooperation with a manufacturer. The supplier has intricate problems too. Special research may eliminate the gadgeteering classification. The proof of feasibility could very well remain.

Instrument manufacturers in many instances now have specialized project engineers or industry consultants who are available to users by contract. These specialists will work with or for a prospective customer on problems in their plant. While this work is specialized, and educated, at least the beginning could very well involve gadgeteering.

There have been many cases where instruments were developed and made by users. Their need not only justified but demanded these developments. After being operational and time proven they were patented and licensed to a manufacturer. Now they are very active and profitable items for both. Even where patents are not immediately profitable, patent attorneys agree they are nice things to have around.

Another case for gadgeteering is a job that needs to be done for a day or two only. Maybe the need is over then or it is to check the feasibility of a permanent installation. For these temporary installations a plant would be lucky indeed to have just the right equipment immediately available. A little substituting and gadgeteering is usually necessary.

What instrument foreman or engineer has not heard many times, "Do we have anything we can do 'this job' with for a couple of days?" After some head scratching and more searching, we usually do. It may be temporarily out of service, a spare, or in the junk pile but use it we do, for a couple of days. From this sometimes come substantial changes.

Gadgeteering is often involved even in the purchase of new instruments. The instrument engineer has a problem when no instrument is available that is designed to handle his exact need. It is pure gadgeteering to buy an instrument or a system of instruments designed for other purposes and adapt them to do a new job. If the designer is smart enough and fortunate, it will work. If not, he can modify it until it does. In the final analysis instruments are bought to do a job and the particular process dicates how well one must do the job.

Some Examples of Gadgeteering

Valve positioners make good temporary level controls on open tanks (Fig. 1).

This drawing is self explanatory. The bellows and spring in the positioner may have to be reversed. The bellows must serve as a feed back bellows to give throttling range. An easy method of changing throttling range is to vary the length of the float lever. The level can be raised or lowered by slipping the float extension rod in the sleeve at the end of the float lever. Simple, but it does a good job for as long as needed.

Valve positioner level control in open or closed tanks where remote indication exists or is desired (Fig. 2).

The level transmitter sends a signal to the remote indicator of three to 15 pounds. A line off this transmitted signal serves as control air to a valve positioner. The valve positioner can then be set on a 1:1 ratio for 100% throttling range and on a 1:12 ratio for approximately 8% throttling range. Thus the throttling range is adjustable from 8 to 100%. The level can be set at any height in the tank with the zero adjustment in the valve positioner. This is a workable installation at lower cost even on new equipment where 8 to 100% throttling range is satisfactory control, and can apply to any process variable.

Improved liquid flow control on old installations with long transmitter lines and a recording controller (Fig. 3).

Until the late 1940's this was a general practice installation. There are many such control loops in use today. If the control is satisfactory, then no problem exists. If not, then the control performance can be considerably improved by installing a stack or any field mounted miniature controller as shown in Fig. 3. While not as good as a standard close coupled control loop, it approaches that performance. It is easily installed and far less cost is involved than with a complete change over.

Scheduled control point changes (Fig. 4).

Many processes have scheduled temperature changes. If a time cycle change is desired, the equipment shown in Fig. 4 will do the job very handily. The temperature controller has pneu-

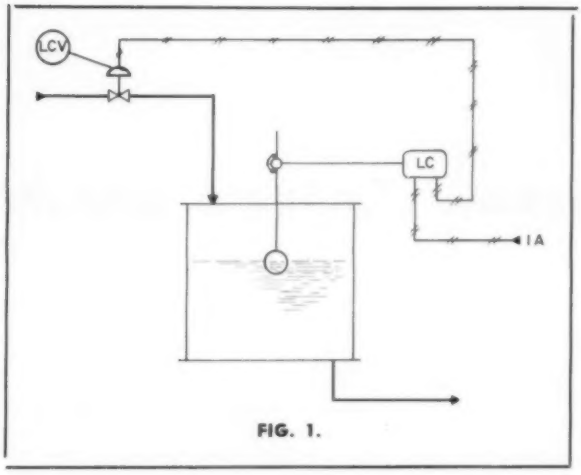


FIG. 1.

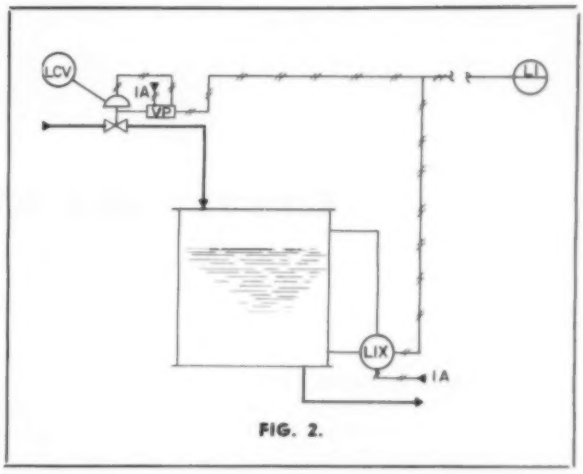


FIG. 2.

matic set. The two pneumatic loading stations are set at the desired temperatures. A timer-operated 3-way solenoid valve is used to select and alternate. Then a manual 3-way valve is employed to close off both and exhaust the air for manual set point operation on maintenance.

The adjustable timer can be set for the desired time on each temperature. The sum of these two periods would be one cycle and would be the same duration as one operation or batch. The timer can be programmed by interlocking electrically with other equipment . . . either to start or stop as other equipment is put in operation.

Programed addition of small volume (Fig. 5).

In a process where it is desirable to charge an additive and vary the rate, the equipment shown in Fig. 5 is very versatile. The component parts are common in most petrochemical plants —a position transmitter, a chart drive and a cam cut from thin aluminum, and adjustable timer that operates a three way solenoid valve. The pneumatic actuator with valve positioner is connected directly to a small piston pump. The position transmitter output, determined by the cut of the cam, sets the length of stroke. The timer alternately energizes and de-energizes the solenoid valve. This determines the number of strokes per minute. Thus the cut of the cam controls the charge rate pattern. The timer setting will determine the total amount charged for the duration of the cam. It is a zero setting that moves the whole charge rate curve up or down. The chart drive or cam drive is a stock item in ranges of one revolution in two to 24 hours. The pneumatic actuator is limited to approximately 10 strokes a minute. This would give a 10:1 total charge ratio after the cam has been determined.

★ ★ ★

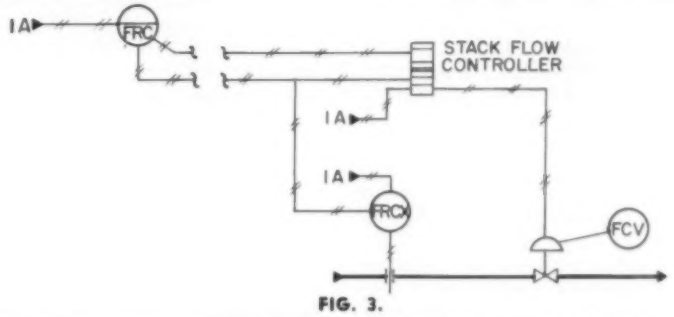


FIG. 3.

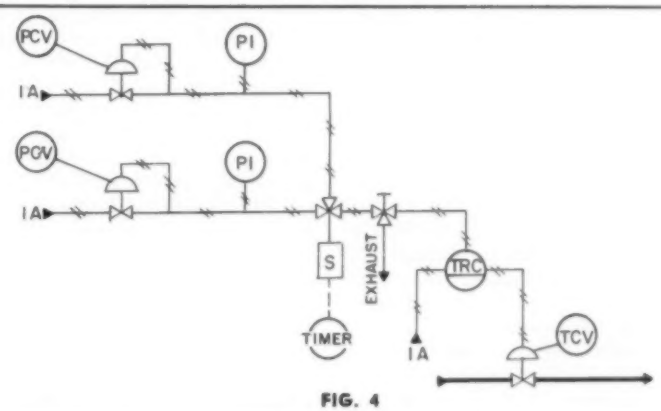


FIG. 4

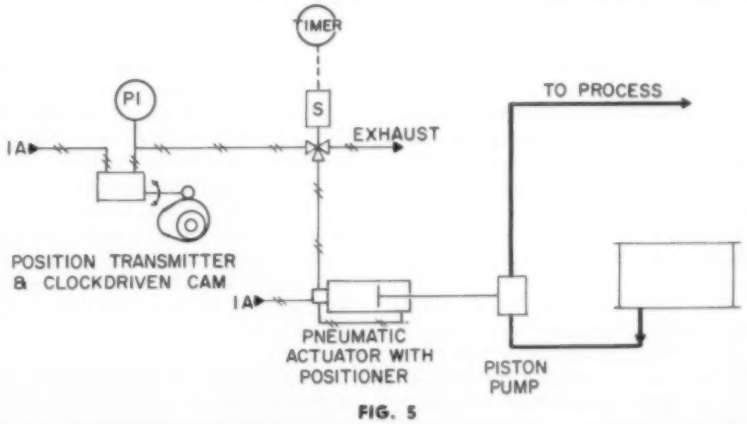


FIG. 5

Instrumentation . . . too much

EDWARD J. BYRNE

INSTRUMENTATION is always a prime target for "whittling down the cost" on those jobs where the dollar figures begin to bust through the estimates. And, conversely, instrumentation also seems to be the favorite area for "gold plating" on jobs that are not tightly bridled by budget figures.

It is somewhat difficult to understand why this situation should exist. After a process is finalized, there is not much that can be done to change the pump or turbine requirements, or the number and design rating of vessels; or even, excluding sidewalks and other trim, the amount of concrete needed. And, except for some ingenuity in design, the pipe, valve, and fitting requirements are generally established.

But, when it comes to the instrumentation, the scale and slide rule cease giving exact answers. We too frequently hear a reference to an over-instrumented plant or an under-instrumented plant. Or, during the start-up of a unit, how often do we suddenly discover that some vitally needed instrument has been deleted or omitted. On the other hand, how often do we observe expensive pieces of instrument equipment being either completely ignored or disregarded because they are not really needed for plant operation.

How can design engineers, in designing a new plant, come up with the realistic instrumentation requirement? I think the answer lies in a pre-instrument design analysis of the total job requirements, including process requirements, operational and production requirements, and maintenance requirements. This total job analysis should then establish a design philosophy, the boundaries of which will prevent skimping on needed instrumentation or the justification of the unneeded "gold plate."

Instrumentation on a project can generally be divided in four major categories.

The first category covers the minimum requirements, the level controls and level gages, pressure and flow controls, heater temperature controls, certain vital temperature indicators and pressure gages, and all the other devices without which the plant could not begin to operate.

The second group consists of that equipment which has been added for operational analysis and maintenance prevention or trouble shooting. This category would include accounting meters, temperature and pressure records, thermometers and thermowells, and even such basic devices as pressure gages on pump discharges. High cylinder head temperature or low oil pressure alarms are typical preventive maintenance devices. This group includes all the instrumentation that, on startup, you are not aware of until something "craters" and then you go scrambling after to get some vital bit of information. But the plant could operate without this equipment, the length of time being problematical.

The third category covers the sophisticated instrumentation—those control systems and instruments designed to take care of the upsets or unusual conditions, or those systems that are needed to make a better product or increase the plant flexibility or rangeability. Cascade and ratio systems, process stream analyzers, analytical controllers, and multi-function relays, would all fall into this group.

The fourth category somewhat overlaps the first three in that it covers the overall instrumentation design rather than specific pieces of equipment. This category covers the instrumentation systems needed to fulfill the designed operational concept of the plant. This concept determines whether transmission systems are needed, whether the instrumentation design should include a central control board, graphic displays, central process alarm systems, automatic shut downs, telemetry, automatic startup of remote units, scanning and automatic logging, computers with print out of operational guides or even reset of control points. It includes all of the systems and equipment that can only be justified by a reduction in over all operating costs.

What, then, is this design philosophy, and how does it relate to these four categories of instrumentation?

First, the process requirements would certainly dictate the instrumentation needed in the first category and be a major factor in determining the equipment needed in the third category. But this determination should not be in terms of hardware but rather in terms of the measurability or the controllability needed. For example, if the process requires that a temperature be controlled, the point should be identified and the tolerance specified. The process requirement does not in itself determine if direct connected or transmission is to be used, if the measurement is to be electrical or by thermal systems, or any of the other variations available in temperature control systems.

Next, the operational analysis requirements of the process must be completely studied. Most of this instrumentation would probably fall into the non-control category. Any process measurement which would require the operator to do something is worth measuring.

In a similar manner, the measurements required for maintenance and troubleshooting should be studied and determined. Again, any measurement that would prevent costly mechanical breakdowns or that would assist in reducing the cost of maintenance trouble shooting, is worth measuring.

But whether these measurements are to be made on recording charts, annunciator systems, or by means of simple devices such as glass stem thermometers, need not and should not be decided at this time. The important point is that these analyses be made from an operations and maintenance viewpoint and, if possible, operations and maintenance people should be consulted.

Usually, the above categories are not subject to "gold plating." Most commonly they are subject to either the "cutting out" procedure or the plain and ordinary "forgot to put it in" procedure. But once the requirements are determined, in terms of functions and measurements rather than hardware, they should be as immune to elimination as are the pumps, vessels, pipe, and other fixed pieces of equipment.

or too little?

ABOUT THE AUTHOR

E. J. Byrne is manager of the instrument engineering department of Brown & Root, Inc., Houston, where his responsibilities include supervision of proposal analysis and estimating, and of the design, procurement, and field checkout of instrumentation systems engineered for the petroleum, chemical, and other process industries. Byrne is a graduate of New York University with a BS in aeronautical engineering. Before joining Brown & Root, he was petroleum industry manager for Minneapolis-Honeywell Regulator Company.

It is in the third category, the sophisticated instrumentation, where over-design is most likely to occur. For example, an engineer will frequently decide that a feed to a tower needs "good flow control" so he will add flow control reset by the level control to attain this goal. What he really means is that he needs "good control of the flow." The flow controller will give good flow control around the set point but, since the set point is reset by the level controller, the actual flow rate is still determined by the level. The cascade system can be justified only by examining the potential upsets or load changes in the secondary loop.

But, functionally, the requirement is still for a steady feed rate to the tower, and it is in this manner that the requirement should be listed. Similarly, all other requirements needed to give the plant the rangeability and flexibility desired, and to meet the process demands for product specification, should be analyzed and listed.

This list of requirements, along with those under the first and second categories, constitute the demand specifications for the job instrumentation. But, before the overall instrumentation design can be finalized, the general type of hardware and systems must be determined. This can only be done by an analysis of the operational concept of the plant.

How many men will operate the plant? What is their degree of skill? How big is the plant area? What type of maintenance people will be employed? Will the plant purchase or generate power? What will be the environmental and atmospheric conditions? These, along with dozens of other similar questions, must be listed and answered.

Why are these questions important to the overall instrument design? Because, since the functional requirements for the process, operations, and maintenance have been established, any extra money spent on instrumentation over the minimum need must be justified by a reduction in operating cost.

For example, if the process requirements dictate that certain streams must be flow controlled, direct connected flow controllers would be the most economical hardware. In this case, the degree of control obtained by the direct connected instrument would probably be as good as any transmitter and receiver controller combination. But, if the overall plant design calls for the minimum number of operators, and incidently, the exact number should be known, a central control room may be justified. But it can be justified only if the size of the plant and other environmental factors would require an increase in personnel to operate the plant at the same degree of efficiency with local, direct connected instruments as with the central control room.

If a central control panel has been justified, the engineer will next look at transmission systems. Electrical transmitters and controllers will probably cost more than pneumatic units. Will you save an instrument air system if you go electric? Or will the valves still be pneumatic with transducers? What will be the saving in winterization of pneumatic lines? Are the transmission distances so great that better control will result with electric control? Will there be an eventual tie-in with computers?

How many required measurements have been listed under the operational and maintenance analysis category? And, of these measurements, how many must be recorded for analysis purposes, even during plant upset conditions which would preclude manual logging? Automatic scanning and data logging will cost more than multi-point recorders and multi-point recorders will cost more than direct indication and manual logging. The least expensive system that can do the job, with the normal crew operating at their required efficiency, is the proper selection for this system.

In a similar manner, this yard stick must be applied to all of the other instrumentation selections such as thermocouples or resistance bulbs or thermal systems, conventional panels or graphic panels, electric or pneumatic shutdown circuits, and other system approaches.

But in making these decisions, the selection must always be weighed back against the process and operational analysis requirements, since the degree of measurability or control could be a deciding factor in the selection of a specific approach to a problem.

This over all job analysis, prior to deciding on the type of instrumentations system that will be used, should not only guard against "cutting out" or omitting essential equipment but should also eliminate unneeded and unjustified "gold plate." ★ ★ ★

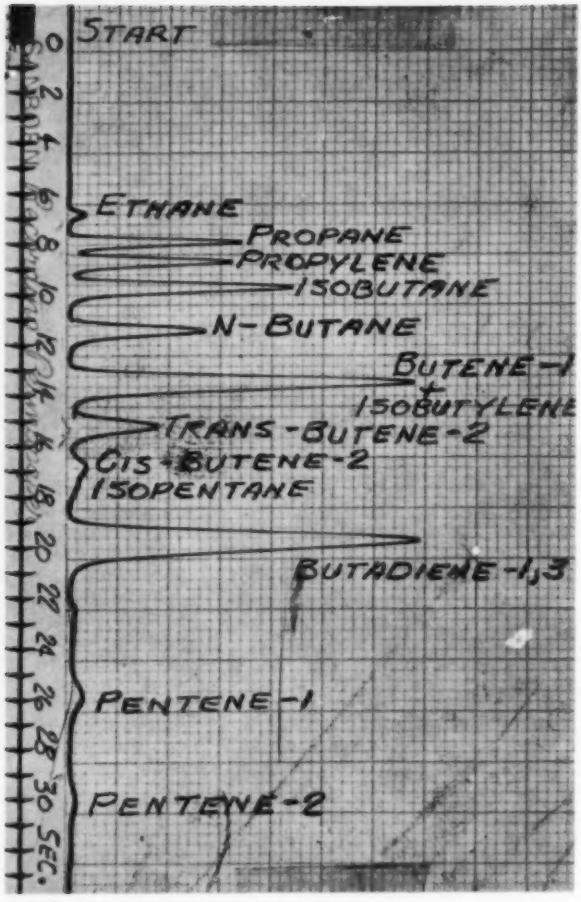


FIG. 1. Record Chart from high speed chromatograph. Note time lapse from start to C_5 analysis in 30 seconds.

Closed-Loop Chromatographic Control Optimizes Deethanizer Performance

DAVID J. FRAADE, *Supervisor, Application Engineering, Analytical and Control Division*
Consolidated Electrodynamics Corporation, Pasadena, California

LITERALLY HUNDREDS of process chromatographic analyzers are in daily use in the Hydrocarbon Process Industry and their application to closed-loop control is only a matter of time.

Initial objections to putting such analyzers into the loop were:

1. The batch-type nature of the analysis with the retention time in the column, resulting in a non-continuous indication of the key component concentration.
2. The long analysis time where, in the then existing analyzers, ordinary cycles were as high as 10 to 20 minutes for C4's.

For monitoring-only applications these times were adequate, but for a closed-loop approach the key component appearance was too infrequent to allow proper action to be taken in the event of an upset. There were actually some brave souls who, even at this time, predicted that this would not be a very serious drawback because of the long lags and surge capacities built in most process loops.

These drawbacks have now been obviated with the development of high-speed chromatograph where analysis cycles are in the order of one minute or less for components through the C5 range. Fig. 1 shows such a record. Instruments are commercially available that reflect design concepts particularly suited to hydrocarbon processing. The approach is a modular one, with the analyzer section suitably housed for Class 1, Group D, Division 1, and the programmer suitable for remote installation in the control room.

Further, the requirement for key component peak storage between analyses has also been met by commercially available memory devices compatible for either pneumatic or electronic control instrumentation.

One of the most universal applications has been in natural gasoline plants. The Reef Corporation in Big Spring, Texas purchased a process chromatograph and a pneumatic control system for their fractionating train. The analyzer sampled the bottom product of the de-ethanizer for ethane as an impurity. The function was to control the ethane content to a feasible and allowable maximum so that the overhead propane product from the downstream depropanizer would meet its vapor pressure specification. Fig. 2 shows the process loop and the associated controls.

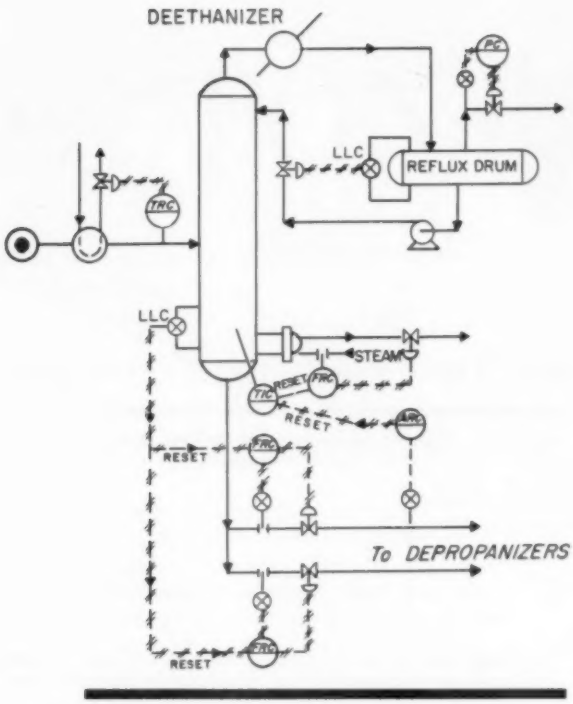


FIG. 2. The process loop and associated controls for the deethanizer.

As is the case with many such plants, the revenue is gained by the sale of the liquefied natural gas products removed from the gas in the oil wells, along with the subsequent sale of the uncondensed portion of the gas. The competition in such an operation is very keen, and, therefore high efficiency must be maintained in processing in order to keep the products on specification. Industry standards limit the concentration of the heavier-than-propane components to approximately 1%. The lighter-than-propane components are limited by the maximum vapor pressure specification.

These lighters are mostly ethane and their tolerances are not set because, in order to produce the maximum possible quantity of propane product, it is advantageous to include as much ethane in the product as the vapor pressure specification will allow and still not exceed the maximum 210 psi allowed.

The deethanizer is the first column in a fractionating train of four columns and its stable operation directly influences the operation of the others. As noted, the ethane content in the propane product is controlled by the ethane in the deethanizer bottoms feeding the depropanizer. The deethanizer feed is made up of three streams from the total liquids removed from the extraction of the natural gas. This feed varies greatly and the problem of ethane content control in the deethanizer bottoms is a common one throughout this industry. Further, this ethane content in the bottoms is also affected by other variables such as feed composition, stream rate and reflux rate.

Usual method of controlling such a tower operation is to employ a temperature controller on a tray near the bottom. However, here it was found that the aforementioned feed composition and feed rate variations resulted in temperature control that, at best, allowed the resulting propane product vapor pressure to vary from 190 to 225 psi, with an average vapor pressure of 202 psi.

It was estimated that if the ethane content of the 202 psi vapor-pressure propane could be more accurately controlled to the desired 210 psi vapor pressure, an additional 2% ethane could be added to the propane product. Achieving this would increase the propane sale value from an equivalent 0.39 cents per gallon when sold as a gas to 4.0 cents per gallon as propane product. On this basis alone, it was calculated that the cost of installing the controlling chromatograph would be amortized in six months.

This has been substantiated in the few months that the system has been in operation. Records of the vapor pressure of the propane product produced during this time indicate an average vapor pressure of 209.5 psi, with respective maximum and minimum values of 207.0 and 214.0 psi.

Another advantage accruing from the installation has been the aid to product recovery and product control offered by the monitoring of the absorber residue gas stream and the deisobutanizer bottoms. Numerous errors in previous existing operations have been brought to light which, had these streams not been monitored, would not have been noticed as quickly nor pinpointed as readily.

Reef's experience with the instrument indicates cost of

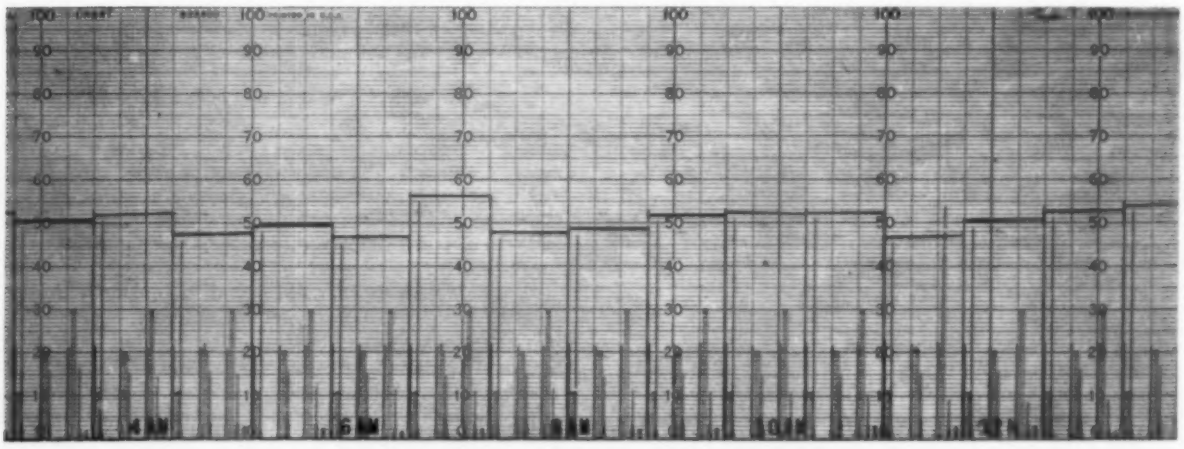


Fig. 3. Chart run showing stream identification.

maintenance of the unit is nominal and the repeatability of analyses is far better than that of laboratory analyses. This is especially true of the control stream, whose composition consists of ethane through nonanes, and which composition is such that it will not completely vaporize at atmospheric pressure and temperature and which is extremely difficult to sample safely and accurately in liquid form. The mechanical selection of the sample into the apparatus is sufficiently dependable to give excellent repeatability.

Fig. 3 is an actual chart run showing the method of stream identification by a "blip" or trace of, say, 10 chart divisions always preceding Stream 1, 20 for Stream 2, and 30 for Stream 3. Stream 1 is the controlling stream which samples the deethanizer bottoms for the ethane content in the range of 0-10%. Stream 2 samples the absorber residue gas and monitors the propane content in the range of 0.5%. Stream 3 samples the deisobutanizer bottoms for isobutane and isopentane in the range of 0-5%.

It would be worthwhile now to examine how the chromatographic analyzer's signal is adapted to closed-loop control. The available process instruments all have a normal output signal of 0-10 mv d-c. In the control system just described, the user wanted pneumatic control, so this was the approach taken.

The analyzer 0-10 mv output signal goes to an emf-air converter which has been modified for storing (or picking) the key control component. Fig. 4 is a schematic of such a typical pneumatic control loop with a chromatograph sensing element.

When the peak to be used for control starts to emerge, a gating signal from the chromatograph opens relay R-1 and solenoid valve S.V.-1 and closes S.V.-2. S.V.-2 is the cut-off relay which locks in the output signal from the 3-mode controller. The emerging peak charges up capacitor C through Diode D. When the peak-top is reached, the voltage across Diode D reverses, and through amplifier A, opens the contacts of relay R-2. This, in turn, closes solenoid valve S.V.-1 and after a short delay, opens S.V.-2, locking in the new air signal beyond S.V.-1.

Suitable delays are built into the system to avoid step changes of output.

The 2-pen control station records both the controlled peak and a complete chromatogram. This configuration offers several advantages:

1. Use of miniature equipment with small panelboard space requirement.

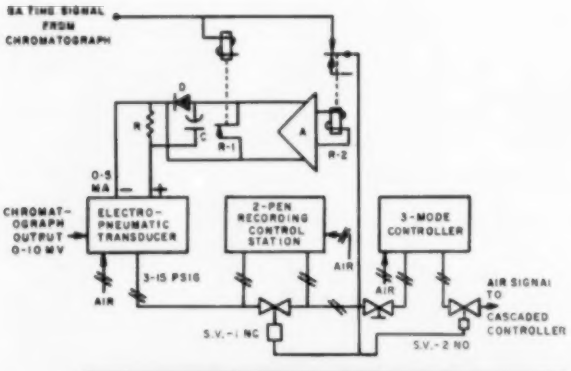


FIG. 4. Schematic diagram of a pneumatic control loop with a chromatograph sensing element.

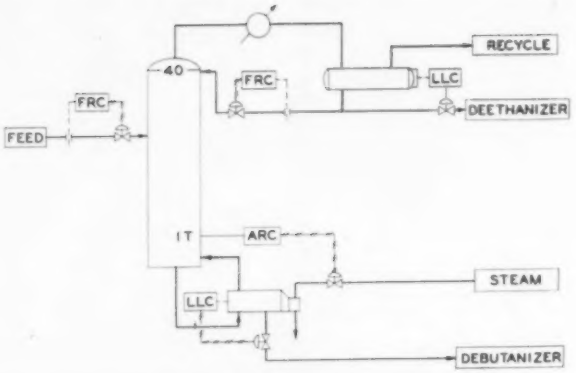


FIG. 5. Automatic chromatographic control of a natural gas liquids depropanizer.

2. A standard 2-pen pneumatic receiver which records both chromatogram and controlled peak, if desired.
3. Complete 3-mode control-proportional band, reset rate, and derivative action. The 3-mode controller contains a special non-overpeaking pneumatic circuit.
4. Option of either pneumatic or electrical output signal.

More recently, it has been concluded that very worthwhile economies can be realized from the tighter process control achieved by direct rather than cascade control, where the speed of analysis and process dynamics permit. The techniques of high-speed chromatography previously mentioned are of particular value in such a case. Fig. 5 shows an example of utilizing a chromatograph to directly control steam to the reboiler of a depropanizer column.

Such a control system has been functioning very successfully for a period of 12 months now with virtually no maintenance. Phillips Petroleum Company has computed payout for such an installation at a butane-isobutane recovery unit on several bases. The instrument is paid off:

1. Every two weeks by increase in product recovery.
2. Every six weeks by improved product quality.
3. In seven months by reduced utility consumption.

Any one of these payouts would have been sufficient to have justified the installation.

In conclusion, it can be seen that with the recent advances made in this field of analysis, the device easily lends itself to closing the loop for continuous control. We have shown how nearly continuous the analyzer may be made through the use of new column techniques. For easy acceptance by plant operating and maintenance personnel, simple components and circuits are employed, together with installation of standard control systems.

This approach shows rapid payout for many HPI applications, among which are isobutane recovery, butane cracking, sulfur recovery, butane dehydrogenation, natural gas liquids separation, and in general, control of process yields and distillation operations. Further, amortization is easily achieved through corresponding improvements in process controllability, resulting in savings in utilities, raw materials, and laboratory burden. ★ ★ ★

DU PONT *Petroleum Chemicals* NEWS

Number 107 in a series of bulletins for the Petroleum Industry

MARCH • APRIL 1961

TETRAMIX* offers new flexibility in choice and use of lead antiknocks

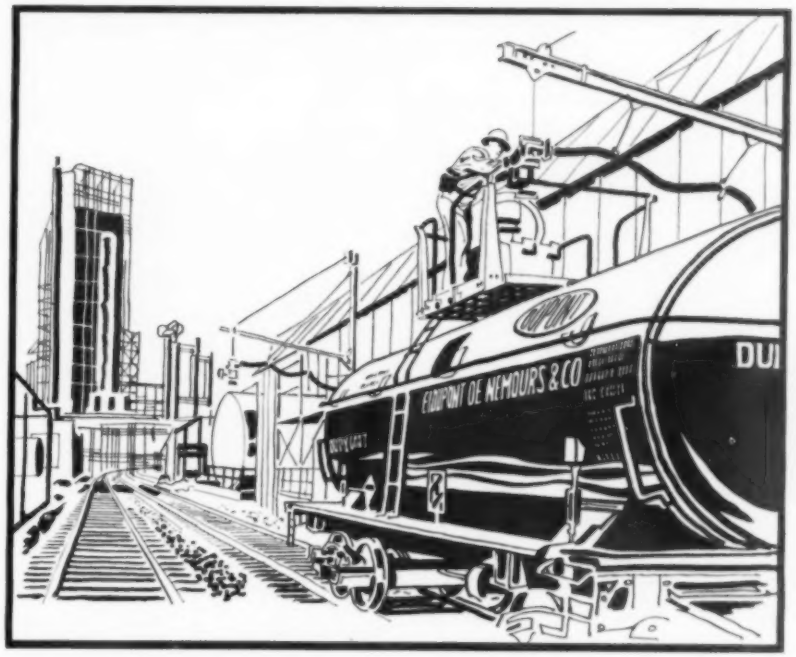
In the few brief months since the introduction of Du Pont TETRAMIX antiknock compound, refiners have found that it offers a new degree of flexibility in their choice and use of lead antiknocks. For example, while its effectiveness varies with gasoline composition (as is true with other antiknocks as well), TETRAMIX is generally effective in low, medium and high dosages.

Results of tests to date indicate that TETRAMIX is also a more effective antiknock in some fuels than either tetraethyl or tetramethyl lead —that is, a given octane number can, in such fuels, be obtained with lower concentrations of TETRAMIX than with TEL or TML. Being a mixed lead alkyl, TETRAMIX brings to many gasolines the best qualities of TEL and TML.

Based on this refining flexibility and the potential savings it offers in blending gasolines to desired octane numbers, TETRAMIX antiknock compound has already won refiners' acceptance. With commercial quantities available, now is the time for *you* to investigate the potential advantages of TETRAMIX.

Because you have a choice of lead antiknocks at Du Pont, you'll get impartial help in selecting the best one for *your* gasoline stocks. Your Du Pont Petroleum Chemicals Division representative can assist you in evaluating the relative merits of TEL, TML and TETRAMIX.

*Trademark



Commercial shipments of Du Pont TETRAMIX are now rolling to refiners.

All in the family

TETRAMIX, Du Pont's new lead antiknock compound, is a combination of all possible tetramethyl-ethyl lead compounds. It provides the best qualities of both TEL and TML in a single additive.

Announced in the fall of 1960, TETRAMIX represents the latest in a series of Du Pont petroleum additive developments that dates back to the commercial introduction of TEL in the early 1920's.

Now . . . 4,507 motorists in a nutshell

The "Summary Report" of the Du Pont "Profile of the Motorist" study is soon to be published. This new booklet will give you a nutshell version of the results of the most extensive survey ever made of the driving-and-buying American public.

In handy, concise form, this new publication will contain answers to questions about how people react to price wars, give-aways, trading stamps, regular vs. premium gasolines, TBA

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT *Petroleum Chemicals* NEWS

CONTINUED **4,507 motorists**

purchases, credit cards, vacation driving and daytime TV . . . and many other facts that further define and analyze the motorist and the market he represents.

In the "Profile of the Motorist" study itself, 4,507 motorists were interviewed in marketing areas from coast to coast. The broad findings, trends and many cross-tabulations will be published in the "Summary Report." Comparisons with earlier DuPont surveys are also to be included.

Copies of the "Summary Report" will be available about April 1. For your copy or for information on the study itself, contact your DuPont Petroleum Chemicals representative.

MANAGER
GULF COAST REGION

CHARLES D. TOWERY, Manager of the Gulf Coast regional office for DuPont Petroleum Chemicals, has been associated with DuPont since 1947.

Starting as a sales service representative for the Petroleum Chemicals Division in the Gulf Coast District, he later was manager of the Mid-Continent region before moving to his present position.

Prior to coming with DuPont, Mr. Towery was employed by Bethlehem Supply Company of Houston, the Gulf Oil Corporation and the Pure Oil Company. He also served as a petroleum advisor in the U. S. Bureau of Ships during World War II.

He received a Bachelor of Science degree in Chemical Engineering from Texas A. & M. College in 1932. He and his wife live in Houston with their four children.

The many DuPont services are available to refiners and marketers in the Gulf Coast area through Mr. Towery's office — to aid in the solution of petroleum additive problems.

Color gives fuel oil a new selling advantage

Oil companies know that the subtle differences between competitive petroleum products often can mark a wide variation in their sales value to consumers.

One of these factors in fuel oils, for example, is the very appearance of the product. Consider the relative sales appeal of fuel oil in its normal state versus the same oil after a distinctive color has been added to it. Perhaps the burner is unaware of the difference, but marketers and consumers alike can recognize a difference. Such a distinction may be the sales advantage you seek.

To this end, DuPont petroleum dyes offer you several built-in features: an unlimited choice of colors, color-fastness for lasting value, availability in powdered, flaked or crystalline forms; rapid deliveries; experienced technologists to advise on color selection, application and use.

Your DuPont representative will gladly offer this advice—or provide you with our latest booklet on DuPont Petroleum Dyes.

"Down the Road" now appearing on America's screens

"Down the Road," the CinemaScope movie sponsored by DuPont to stimulate interest in auto travel, is now appearing in movie theaters across the country.

Narrated by Lowell Thomas, the ten-minute color featurette is an adventure in itself — a thrilling visit by automobile to all corners of America, from the Painted Desert to New England, from the sands of Daytona to the mountains of Canada.

In sponsoring "Down the Road" DuPont is promoting expansion of the demand for petroleum products by encouraging a greater interest in the heritage and beauties of America—and the ease and comfort with which they are available via automobile.

Motorists in *your* marketing area will soon be seeing "Down the Road." If you are interested in tying in with the travel promotion value of this film, your DuPont Petroleum Chemicals representative can give you data on local bookings.

RADIO CITY MUSIC HALL, New York City, was the site of the Eastern premiere of "Down the Road," in mid-January.

SALES OFFICES

Chicago 3—8 So. Michigan Ave. . . . RAndolph 6-8630
Cleveland 15—101 Prospect Ave. . . . . MAin 1-3422
Houston 2—705 Bank of Commerce Bldg. . . . . CApitol 5-1151
Los Angeles 17—612 So. Flower St. . MAdison 4-1354
New York 20—45 Rockefeller Plaza 212-CO-5-2342
Philadelphia 2—3 Penn Center Plaza . LOcust 8-3531
Pittsburgh 22—1 Gateway Center . . . . ATlantic 1-2933
San Francisco 4—111 Sutter St. . . . . EXbrook 2-1934
Seattle 3—4003 Aurora Ave. . . . . MElrose 2-6977
Tulsa 1—1811 So. Baltimore Ave. . . . . LUther 3-8581
In Canada—DuPont of Canada Limited, Petroleum Chemicals, 85 Eglinton Ave. East, **Toronto 12**, Ontario . . . . . HUdson 1-6461
OTHER COUNTRIES:
Petroleum Chemicals Division, Export Sales, Wilmington 98, Delaware . . . . . PRospect 4-5009

DU PONT
REG. U.S. PAT. OFF.

Better Things for Better Living
. . . through Chemistry

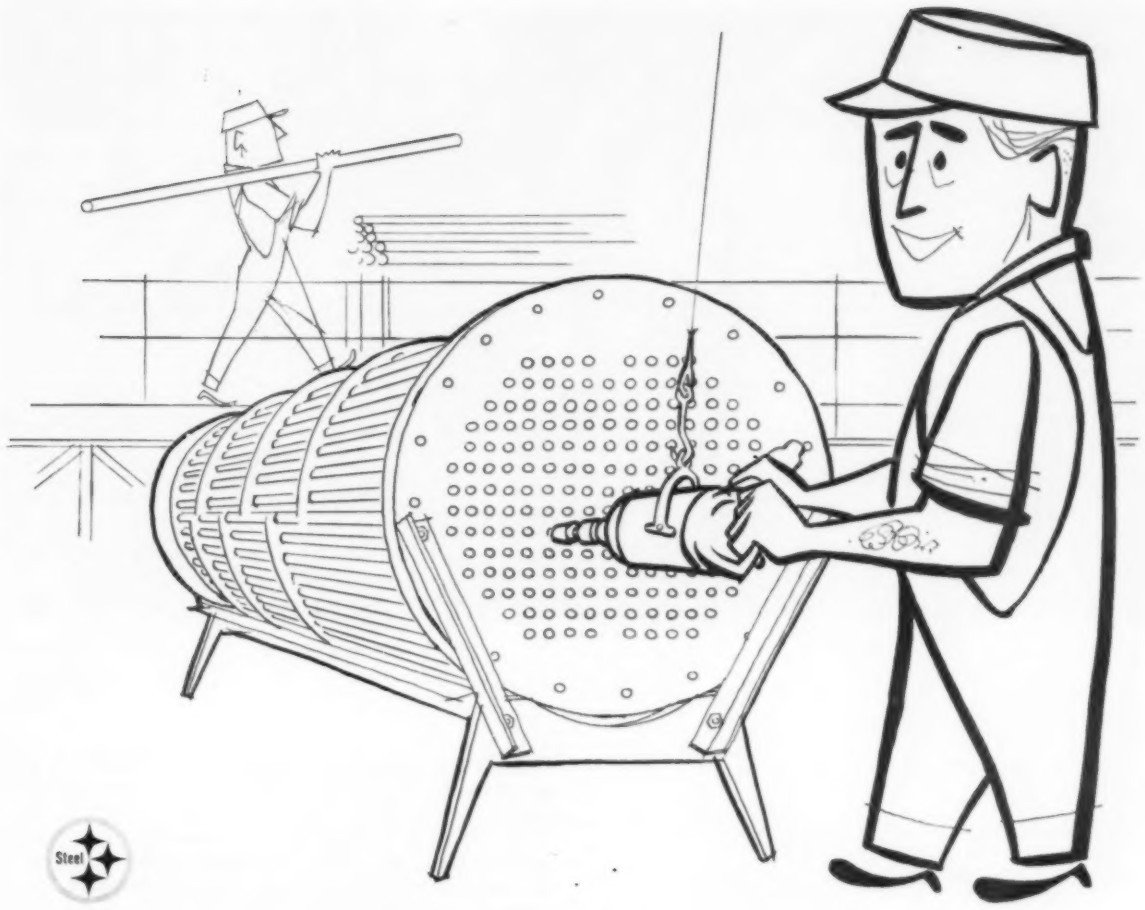
DuPont Lead Antiknock Compounds and other Petroleum Additives

OVER

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

A-19007

Printed in U.S.A.



YOU GET BETTER FIT, EASIER ROLL-IN AT LOWER COST

with B&W Lectrosonic Heat Exchanger Tubing

Uniformity of dimensions. Strength of weld. Proper combination of physical and mechanical properties. This is the way B&W produces its Lectrosonic® carbon steel heat exchanger tubing to be sure it fits perfectly and rolls in easily for fast, economical installation.

You save on initial cost, too, because Lectrosonic heat exchanger tubing costs much less than seamless which it has been designed to replace. And there's no sacrifice of quality. B&W's integrated quality control procedures—with 100% ultrasonic testing of the weld in line production—results in a tube equal or superior to seamless. Care to investigate? Just call your local B&W District Sales Office or write for Bulletin TB-431. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pennsylvania.

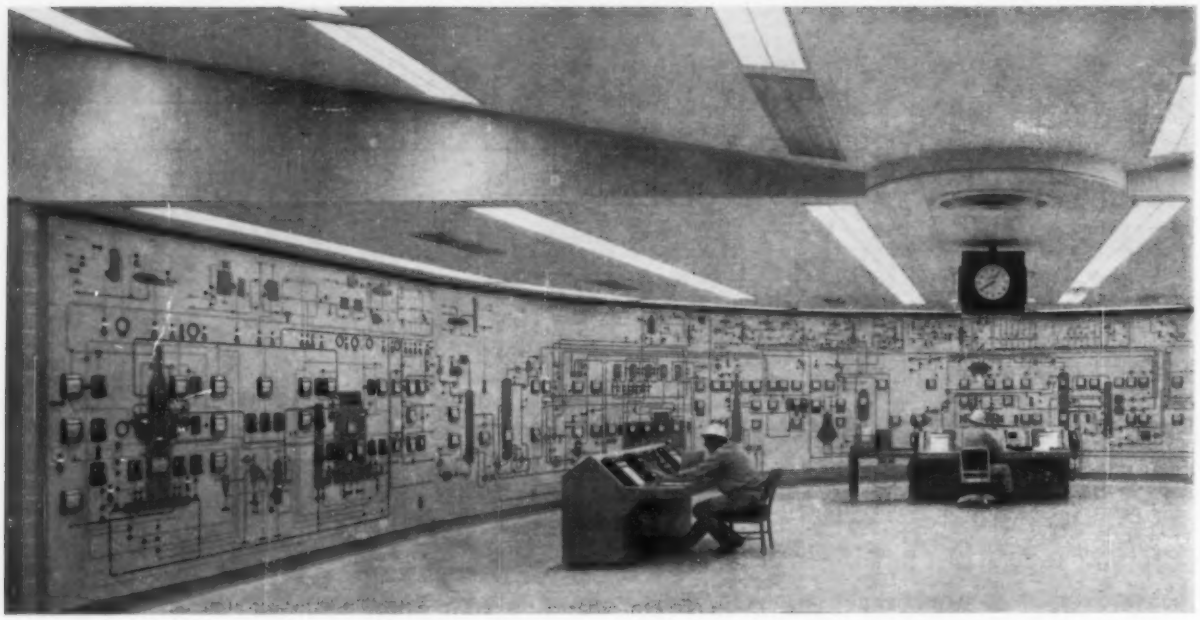
B&W

THE BABCOCK & WILCOX COMPANY

TUBULAR PRODUCTS DIVISION

TA-1005-P

Seamless and welded tubular products, solid extrusions, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels and special metals



CONTROL OF INTEGRATED STEAM AND PROCESS FACILITIES

WALTER S. BOWERS, *The Foxboro Company, Foxboro, Mass.*

THE HYDROCARBON PROCESS INDUSTRY today trends toward integration of steam facilities with processing units.

An excellent example is the CO boiler on a fluid cat cracker. Here, the steam producing facility is tied in on the regenerator flue gas stack. In some instances, it supplements the plant's steam supply. In others, it may be the refinery's principal steam producer. Thus, the cat cracker provides much of the fuel, a large part of the load, and most of the source of potential upset.

Frequently control and operation of this boiler is handled at the cat cracker. Almost always, stringent requirements are placed by the operator and instrument man on the flexibility, reliability and compatibility of the control equipment.

This emphasizes the need for applying modern control technology to maximize equipment efficiency and minimize operating attention. From the instrumentation point of view, here are some of the considerations which frequently bear on the situation:

1. The controllers must be quick to sense changing conditions and accurate to correct them so as to avoid aggravating upsets. Modern *process instruments* are built to be more flexible, compact, and dynamically responsive than their predecessors or the purely combustion types.
2. Operators and instrument mechanics have used and maintained process-type instruments for years. They understand the functions and are more familiar with the settings and adjustments. They are not as liable to become confused during upsets as they would if combustion and process types were intermixed.
3. Usually, HPI plants maintain an inventory of process-type instruments. Generally this can serve both the boiler and process without greatly enlarging the stock.
4. Process-type instruments are more universal in nature and designed to handle the extreme conditions imposed by industrial operations. Thus, they can be applied equally well throughout a plant without being limited to combustion applications.

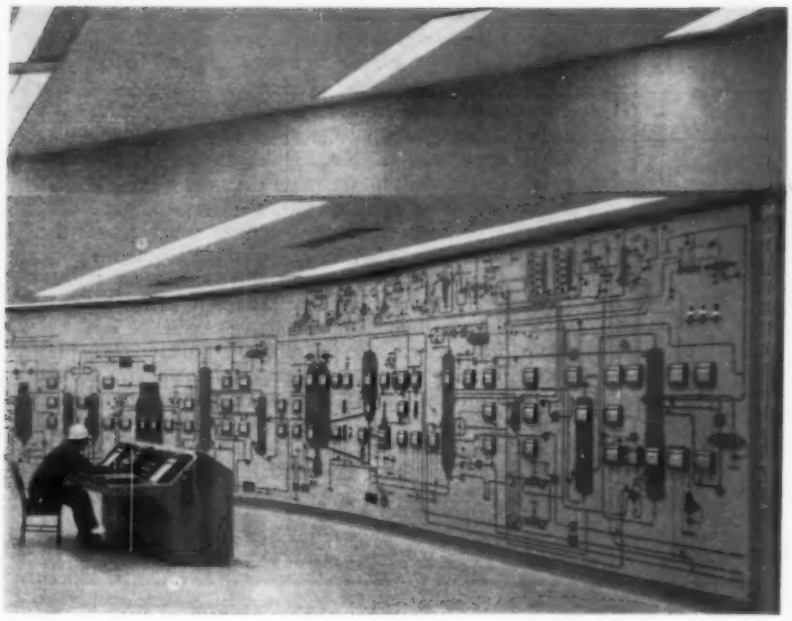
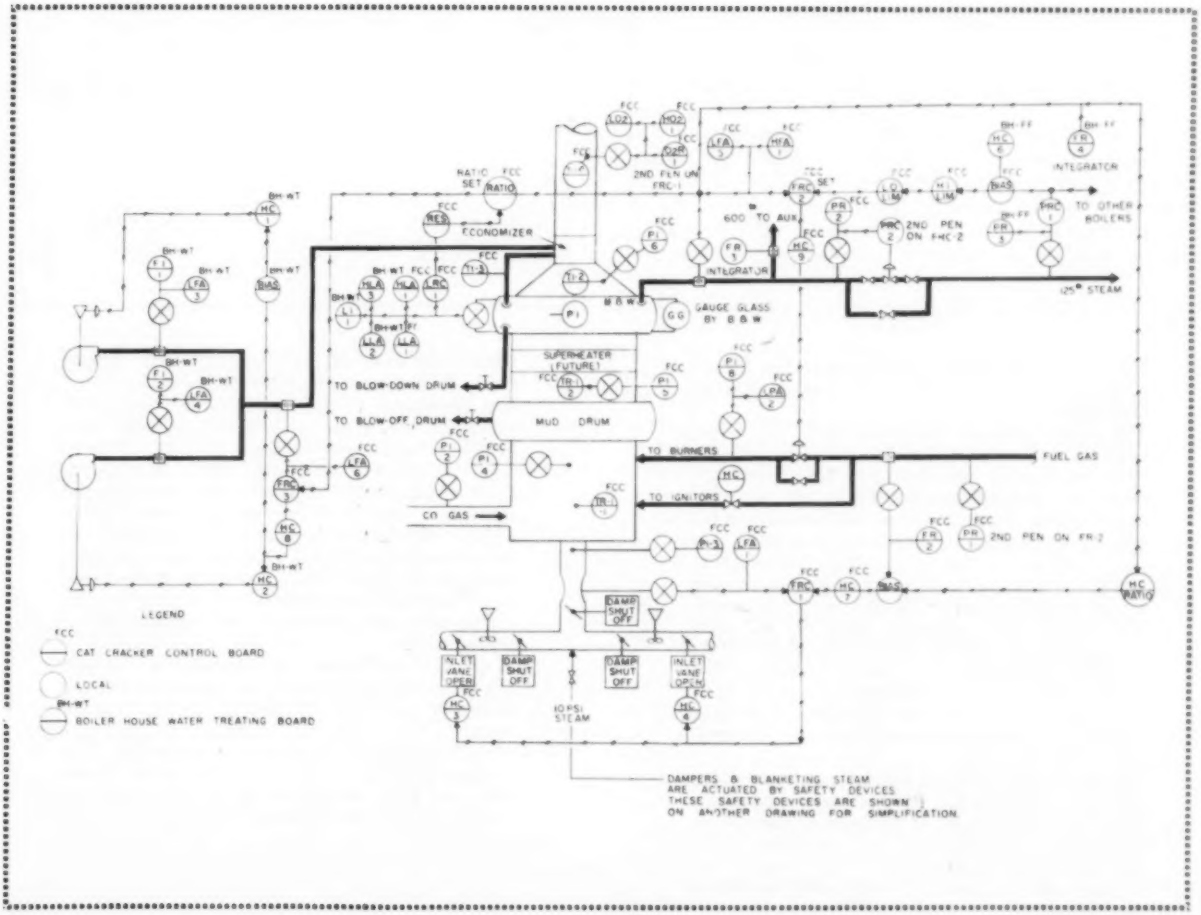


FIG. 1. Integrated refinery control board. CO and power boilers are on far left end of the board.

Fig. 2. Control System for CO Boiler.
The pressure controller PRC-1 detects load changes as a change in steam header pressure. It pneumatically sets the set point of the total steam flow controller FRC-2. High and low limits keep the boiler from being overfired or operated too low to maintain combustion of CO gas. FRC-2 then activates the fuel gas valve to provide the fuel required to supplement the CO gas. The CO gas is normally allowed to enter the boiler to the limits of availability. Combustion air to match the total fuel fired is maintained by a steam flow-air flow ratio controller FRC-1, actuating dampers on the inlet to the forced draft fans. This arrangement is used because of physical inability to measure CO gas and variation in Btu content of the fuel gas. The oxygen recorder (O_2R) serves to advise the operator of excess air. This can then be readjusted manually.



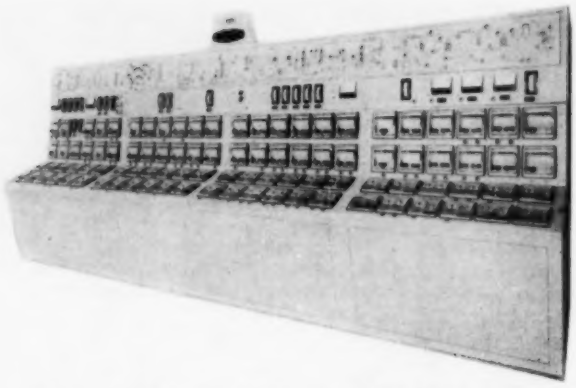


FIG. 2-A. Integrated petrochemical plant control board. The entire operation uses electrically operated instruments. The boiler controls are in the console section at the far left.

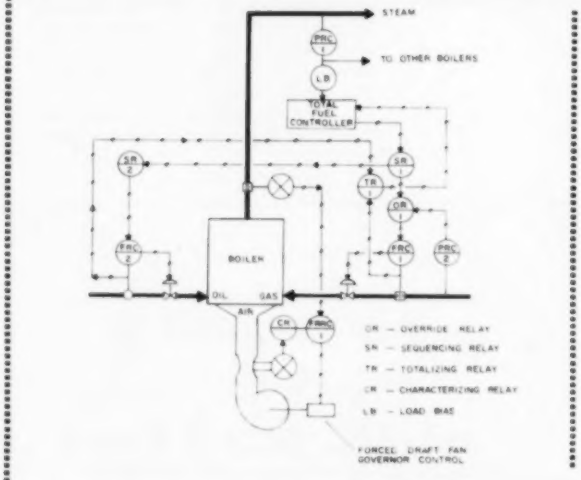
Combustion controls, themselves, must be able to maintain constant steam conditions in spite of processing changes and upsets. The average operator expects to be able to place the same degree of confidence in them as he does in conventional process instruments. Furthermore, he is particularly concerned that the steam conditions remain stable when he has process upsets. Unless he can do this, a minor upset can snowball into a major one.

To meet these requirements, the manufacturers of conventional process instruments have expanded and redesigned their product line. They have also added people with operating and combustion control experience to their staffs.

The result is that now a process plant can have a single, integrated manufacturing and steam producing facility with compatible process-type instruments. Usually, this will provide operating and manpower economies. It will always provide greater flexibility and reliability than was previously possible.

Let's take a look at some of this flexibility . . .

1. The conventional differential pressure transmitter has now been supplemented with auxiliary square root extractors.



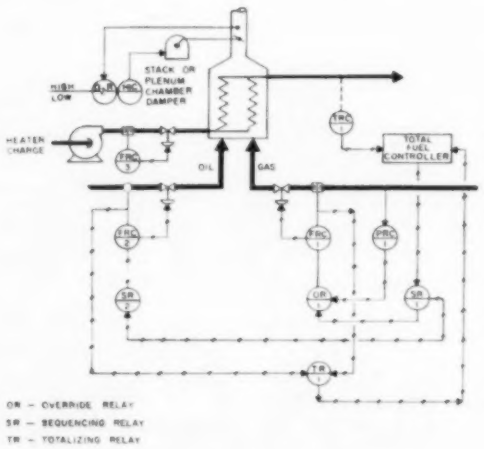


FIG. 3 Combustion Control System For Mixed Fuels of (Varying Gas Btu) with Gas Availablity Override.

The master pressure controller (PRC-1) senses load changes and, in the case of an increase in demand, signals the fuel gas flow controller (FRC-1) to increase the BTU input accordingly. This is so because sequencing relay (SR-1) diverts the signal here first. If the gas is not available in full, the availability pressure controller (PRC-2) will override and reduce the signal in proportion to the gas header pressure. The fuel oil flow controller (FRC-2) will then be signaled through the sequencing relay (SR-2) to make up the remaining fuel requirement. The fuels will then be totalized through relay (TR-1) as a measure of total Btu fired. This then becomes the fuel measurement signal to the total fuel controller.

The steam and air flows are measured and properly characterized for fuel or boiler nonlinearities. This ratio is used as the basis of controlling combusion air efficiently. Any deviation from the established ratio results in a signal to the forced draft fan governor mechanism to restore the balance.

FIG. 4 Process Heater Control For Mixed Fuels With Gas Availability Override.

The furnace outlet temperature controller (TRC-1) will sense a load change such as a heater charge rate increase, detecting it as a drop in temperature, TRC-1 will then signal the fuel-gas controller (FRC-1) to increase the Btu fired. This is so because sequencing relay (SR-1) diverts the signal here first. If gas is not fully available, PRC-1 will sense it and cut back on the signal through override relay (OR-1). The fuel-oil controller (FRC-2) will then be forced to match the signal and provide the required fuel.

A critical combustion air controller is not usually required since excess air requirements are normally governed by heater design, type of burners, etc. The air generally exceeds the amount required to support combustion. The oxygen analyzer is an operating guide which serves to keep the excess air within reasonable bounds. It will usually justify itself on fuel saved.

2. Simple, economical, space-saving flow integrators can now be plugged in where convenient.
3. A multitude of computing, averaging, biasing, and ratio relays is available.
4. Special characterizing relays can be furnished for non-linear measurements or unusual problems.
5. A new target meter, specifically designed for fuel oil, can measure flows as low as 5 gal per min.
6. Piston operators have been redesigned for the conditions normally encountered in petrochemical plants and refineries.
7. Remote-set controllers, long standard for process, are now routine for steam production where distances in excess of 250 ft are involved. The result is quicker recovery from upset on fuel gas, fuel oil and feed-water control systems having very short time constants. Additionally, the controls can be centralized in the process control rooms some distance from the boilers.
8. Conventional small-case strip chart instruments with "piggy-back" controllers offer the same compatibility and economy of space as the instruments on the regular process unit.

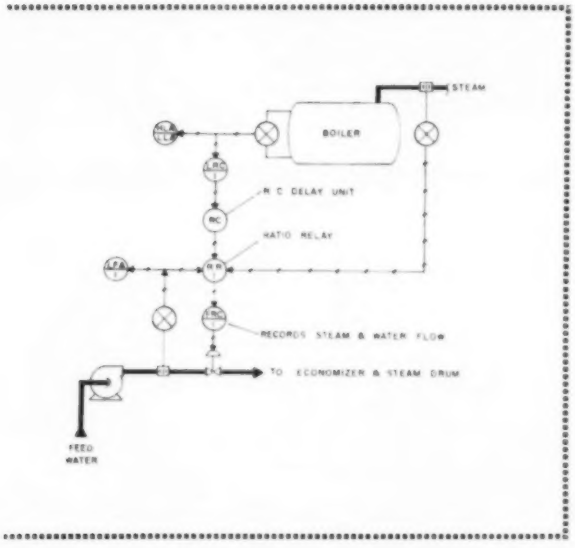


FIG. 5 Typical 3-Element Feedwater Control System Using Process Instruments.
The steam and water flows are measured and controlled in proportion to the boiler steaming rate at a suitable ratio by means of Relay (RR-1 and flow controller FRC-1). The level controller (LRC-1) resets the set point of the ratio controller for upsets due to sustained load changes. The automatic reset function of the controller (FRC-1) always remains in the circuit to provide rapid recovery for load changes. The delay unit (RC) serves to minimize "shrink" and "swell" effects which would be introduced by the level controller on rapid load changes or blow-down operations.

Walter S. Bowers recently joined The Foxboro Company, oil and gas industries division, after 12 years as instrument engineer and supervisor of the control systems group at Standard Oil Company of Ohio. Previously he served with American Cyanamid Company as a chemical engineer and with H. K. Ferguson Company as an instrument engineer. He has a BS in chemistry from Alfred University and studied petroleum engineering at Case Institute of Technology.

For those who encounter even longer distances or who wish to consider data handling and computing facilities, either now or at a later date, similar solid state electronic controls and instruments are also available as standard devices.

To illustrate some of these features and show the variety and flexibility of arrangements, let's look at a few actual installations.

Fig. 1 shows a refinery graphic panel where the CO and power boilers are controlled from the central process control room. These two boilers provide the steam requirements for the entire plant including all of the turbine drivers and the process. Precise control is automatically maintained from the "nerve center" in spite of demand variations and upsets.

Fig. 2 shows a combustion control diagram for an actual boiler. Here the boiler was added to an existing cat cracker. The instruments are remotely set from the control board, located in an existing boiler house alongside a conventional combustion control arrangement. Some of the key functions, such as operation of the CO stack damper and the water seal drum, must be carefully coordinated with the operation of the cat cracker.

Operators of the cat cracker are keenly concerned because the boiler is a "piece of pipe" on the end of the regenerator. It's important to them because it may aggravate an upset. This could lead to afterburning or even a catalyst reversal. As the prime supplier of steam, it's also critical to their gas compressor turbine. Obviously, the steam boiler and the process are critically related.

A console arrangement incorporating boiler controls or a petro chemical plant panel is shown in Fig 2-a. The installation uses solid state electronic instruments.

Fig. 3 shows a schematic control diagram for a large West Coast refinery boiler plant using multiple fuels and preferentially firing gas, when available. Only the essential control features have been shown to simplify the diagram. In this particular plant, a CO boiler also ties in with the regular facility, although separated from it by nearly 2000 ft.

This type of instrumentation is not limited to boiler combustion control. It is quite flexible for all types of control

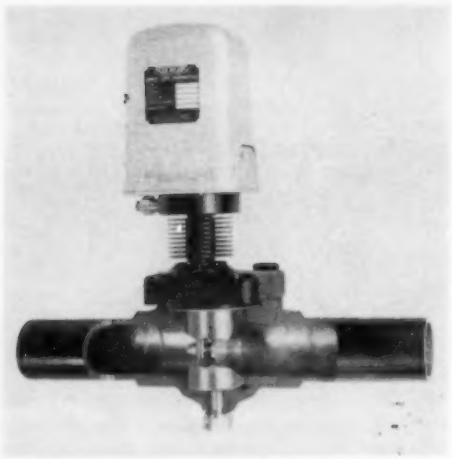


FIG. 6 Target meter with body cut away to show internal construction.

problems. For example it facilitates the efficient control of process heaters applying multiple fuels and encountering wide swings in load.

With an arrangement slightly modified from that shown in Fig. 3, it is possible and economical to control heater outlet temperature automatically and thus ride through fuel swings. This is illustrated in Fig. 4.

The real point to remember here is that better control will be maintained because the instruments automatically swing fuels as required. There is no lag between the discovery of temperature drift and manual switching to oil burners. Obviously the payout is in better product control and less operator attention.

Let's take a more detailed look at some of the equipment and the improvements in control which the designer can now expect with them:

1. Feed-water control

Conventional 3-element systems have been designed along process control lines (see Fig. 5). Here feedwater and steam flows are ratio controlled, with the level controller pneumatically resetting the ratio set point.

Unlike some other arrangements, the "automatic reset function" is always present in the circuit. Thus, recovery from upset is quicker and the effects of shrink and swell are counteracted. The controller adjustments are easier for an average instrument man to make, since they correspond to those he normally encounters on conventional process instruments.

2. The target meter

The target meter shown in Fig. 6 is especially suitable for fuel oil flow measurement. It is available in sizes from ¾ through 4 in. It can handle viscous fuels with a Reynold's number down to 250. Flowing temperatures and viscosities are not particularly limiting.

It's accurate and quite compatible with conventional instrument systems. In fact, it looks and handles very much like a differential pressure transmitter. However, unlike orifice type meters, piping configurations and installation requirements are quite liberal.

It mounts directly in the line and can be installed in a 3 to 5 ft run of pipe. Thus, it is ideally suited to the wide gamut of heavy fuel oils normally encountered in industry.

Typical calibration curves show the constancy of the discharge coefficient with Reynold's number at a 0.8 Beta ratio. The curves for all sizes are quite similar.

3. Control of multiple fuels

Control of multiple fuels with preferential firing of gas presents a typical problem in many refineries. This kind of situation offers a refiner an opportunity to absorb ups and downs in process gas make by automatically handling fluctuations in the boilers. A properly instrumented boiler can do a lot to level out the gas system swings, thus smoothing out the performance of the process heaters and reducing the amount of gas flared.

The process-type controller offers an excellent opportunity to design an instrument arrangement which will carefully balance the selection and sequence of fuels. By a novel arrangement, shown in Fig. 7, it is possible to control the fuel load accurately and precisely. This is done by sequencing the fuel flow controllers with the demand from a master instrument. Thus, the total measured fuel rate is kept in balance with the load requirements. Gas is preferentially allowed to meet these requirements up to the limit of its availability. Fuel oil supplements it until the master signal is satisfied.

A number of arrangements are available so that the combustion air can lead the fuel on an increasing demand. This minimizes "flame out" when fuel oil is being fired. Frequently, a special characterizing relay is also employed to permit optimum combustion air efficiency, no matter what the variation or combinations of fuel mixture are.

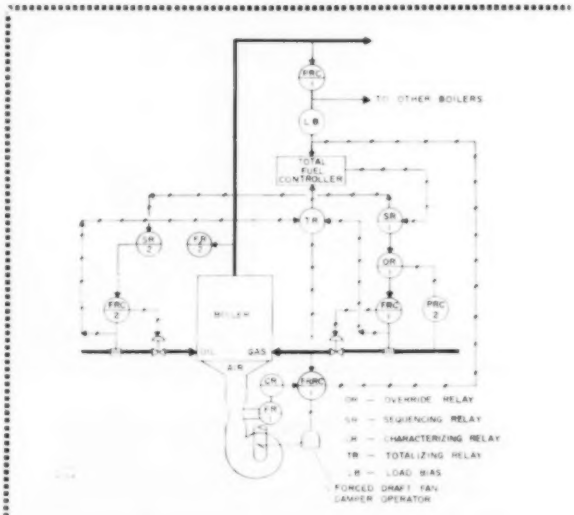


FIG. 7 Boiler Control For Mixed Fuels (Gas Btu Stable) With Gas Availability Override. The master controller (PRC-1) senses a load change. Assume an increase in load. It then signals an increase in fuel and combustion air. The air requirement is applied on the fuel-air ratio controller (FRRC-1). From here it goes to the damper operator.

The fuel requirement is applied on the total fuel controller. The fuel controller signals an increase in gas first. This is so because gas pressure exists, PRC-1 and OR-1 will reduce the signal to FRC-1 gas flow controller. The Btu signal then goes to the fuel oil controller (FRC-2) through sequencing relay SR-2. Additional features, like overfiring limit relays and mixed fuel combustion air compensation, can be added where needed.

Naturally, the simpler systems are employed for the more straightforward boilers and on process heaters. The important thing to remember is that a variety of process type instrument arrangements are available in practically any combination required.

4. Computing relays

These were first popularized by the combustion control suppliers, primarily for boiler control systems. This was feasible because the combustion and steam generation processes were better understood. They used a multi-element technique of control. Thus by tying together all of the related variables of a complex system better control was obtained.

As a matter of fact, this was the start of analog computer technology in process control. The earliest relays were not accurate enough for a process application because of limited sensitivity and excessive hysteresis at the 3 to 15 psi signal level.

As process functions became better known, the advantages of these analogs became more apparent. In response to the demand improved models were developed by the process instrument manufacturers.

Now these relays are available in both electronic and pneumatic models. They are able to add, subtract, average ratio, and bias all sorts of linear signals. They can even be used to relate square root signals over a limited range. Special devices are even available to characterize signals with non-linear relationships.

The result is that the number of functions that can be computed is limited only by one's imagination.

Although the preponderance of applications still exist in combustion control, more and more arrangements are being used for process applications. Several of the combustion control hookups are shown in Fig. 3 and 7. The **Internal Reflux Controller** developed by Phillips Petroleum, is a widely documented process analog.

Likewise, Fig. 8 shows a relay on a hot oil circulating system for a solvent recovery loop of a lube plant.

Another typical illustration is the one used for controlling a propane vaporizer on an emergency standby fuel system for HPI plants. This is shown in Fig. 9.

Industry profits are continually being squeezed by rising costs and keener competition. This has forced the engineers in HPI to take a harder look at the efficiency of their plants and personnel. Opportunities for improvement have become apparent. One result has been more and more integration of steam facilities into process.

Bibliography

1. "Application of Conventional Industrial Instruments to Power Plant Control" — W. H. Fortney, *Instruments* — December 1947.
2. "How To Instrument Refinery Boilers" — Robert Silva, *Oil & Gas Journal* — May 7, 1956.
3. "Process Type Instruments Installed on New Refinery Boiler" — H. G. Morgan, *Petroleum Refiner* — October 1957.
4. "Computer Control of Distillation Reflux" — D. E. Lupper and D. E. Berger, *ISA Journal* — June 1959.
5. "Basic Multiloop Control Systems"—Charles L. Mamzic, *ISA Journal* — June 1960.

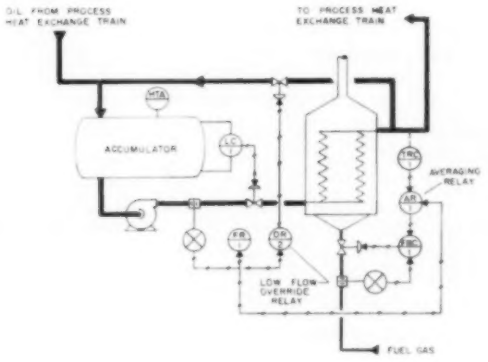


FIG. 8 Lube Plant — Hot Oil Heat Exchange System.
The control of this type of heater is conventional with the temperature controller (TRC-1) resetting the fuel-gas controller (FRC-1) to hold the outlet temperature constant. The process heat exchanger train may cause changes in heater charge rate due to fluctuating requirements. Averaging relay (AR-1) warns of a change and resets the control point of the fuel controller without waiting for a change in furnace outlet temperature. Override relay (OR-2) detects low flows that could cause coking in the tubes. It then opens the control valve in the bypass line and diverts some hot oil back to the accumulator to maintain the furnace flow above the minimum set point.

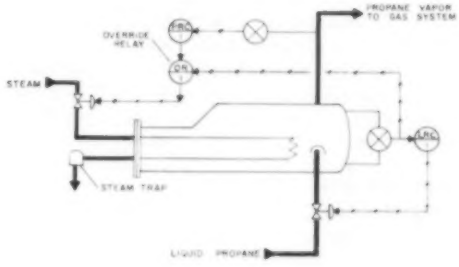


FIG. 9 Standby Propane Vapor Control System.
A drop in gas system pressure will flash off some propane. This will lower the liquid level in the kettle. The override relay (OR-1) is present to speed up the system response by actuating the steam valve more quickly. Control would be quite a bit more erratic if independent instruments were used, without the relay device. Both control actions would probably have to be adjusted for stability as well as responsiveness and the system would not co-ordinate as well.

★ ★ ★

DISTILLATION . . . *in view of modern developments*

KENNETH F. GORDON, *Dept. Chemical & Metallurgical Engineering, University of Michigan, Ann Arbor, Michigan*
JAMES A. DAVIES, *Chief Design Engineer, Texaco, Inc., Houston, Texas*

GRAPHICAL SOLUTIONS of binary and ternary distillation problems are important not because they are accurate or easy to apply, but because they show pictorially the factors which are important and their inter-relationships. This is especially true for ternary distillation as compared with binary because at a given temperature the composition of a saturated ternary mixture is not fixed. For instance, the feed temperature may be the same as the feed tray temperature, but the feed and feed tray compositions may be appreciably different. A clear understanding of these inter-relationships forms the basis for development of the theory and understanding of the complexities of multicomponent, azeotropic and extractive fractionation. White[1] has applied the graphical approach to ternary and quaternary distillations very effectively to describe the inter-relationships of the fractionation variables such as trays, reflux, charge point and compositions.

This discussion will be limited to the graphical development of the inter-relationships of the fractionation variables for a simple ternary system. The simple distillation curves for the system used in this discussion are shown on Fig. 1. These curves are the loci of the vapor-liquid tie-lines at the bubble point. Arrows indicate the change in composition of a particular liquid when an infintessimal amount of vapor is distilled off. One temperature section for illustration is shown along with a few tie-lines and the vapor and liquid saturation curves. This figure indicates that A component is the least volatile, C is the most volatile, and B is intermediate.

Graphical Method

Graphical method used is Bonilla's[2] and is illustrated on Fig. 2 to 5. Symbols used in the figures are:

D = distillate mole rate
F = feed mole rate
L = liquid mole flow rate from a tray
V = vapor mole flow rate from a tray
W = bottoms mole rate
x = liquid phase mole fraction
y = vapor phase mole fraction

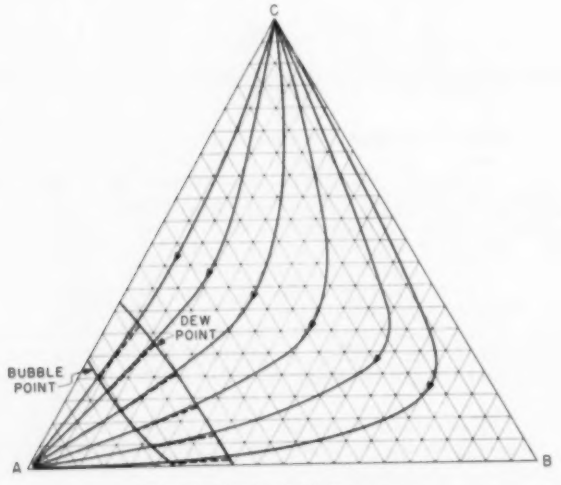


FIG. 1. Simple distillation curves.

The bar superscript refers to the stripping section and the subscript numbers refer to the tray numbers counting from the bottom for the stripping section and from the top for the rectifying section, and n is any particular tray. The f subscript refers to the feed tray, w to the bottoms product, d to the distillate product and F to the feed. Material balances around the stripping section are:

$$\bar{L} = \bar{V} + W \quad . \quad . \quad . \quad . \quad (1)$$

$$\bar{L}\bar{x} = \bar{V}\bar{y} + Wx_w \quad . \quad . \quad (2)$$

Below the first tray:

$$\bar{L}_1\bar{x}_1 = \bar{V}_w\bar{y}_w + Wx_w \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Above the first tray:

$$\bar{L}_2\bar{x}_2 = \bar{V}_1\bar{y}_1 + Wx_w \quad . \quad . \quad . \quad . \quad (4)$$

Above the nth tray:

$$\bar{L}_{n+1}\bar{x}_{n+1} = \bar{V}_n\bar{y}_n + Wx_w \quad . \quad . \quad . \quad . \quad (5)$$

Since each tray is an equilibrium tray and the lever arm rule applies to ternary diagrams, these equations are plotted on Fig. 2. Lines radiating from point W are called operating lines as they represent the above material balance equations and the dotted lines connecting x and y are the tie-lines at tray temperature. The first operating line giving y_w is also a tie-line (see Equation 3). Composition of the liquid entering a tray is obtained from the ratio of the distances, such that:

$$\frac{\bar{L}_{n+1}}{\bar{V}_n} = \frac{\bar{y}_n \text{ to } x_w}{\bar{x}_{n+1} \text{ to } x_w} \quad . \quad . \quad . \quad . \quad . \quad (6)$$

Fig. 3 illustrates the method for the rectifying section. Here the corresponding equations are:

$$V = L + D \quad . \quad . \quad . \quad . \quad . \quad (7)$$

$$Vy = Lx + Dx_d \quad . \quad . \quad . \quad . \quad (8)$$

counting from the top:

Above the first tray

$$V_1y_1 = V_1x_d = L_dx_d + Dx_d \quad . \quad . \quad . \quad (9)$$

Above the second tray:

$$V_2y_2 = L_1x_1 + Dx_d \quad . \quad . \quad . \quad . \quad (10)$$

Above the nth tray:

$$V_ny_n = L_{n-1}x_{n-1} + Dx_d \quad . \quad . \quad . \quad . \quad (11)$$

y_n is obtained as in Equation 6 by:

$$\frac{L_{n-1}}{V_n} = \frac{x_d \text{ to } y_n}{x_d \text{ to } x_{n-1}} \quad . \quad . \quad . \quad . \quad . \quad (12)$$

If constant molal overflow obtains, then the L/V ratios are constant and knowing the vapor-liquid equilibrium, the number of trays can be laid off with ease on a ternary diagram. As may be noted from Equation 3 and 9 certain assumptions have been made as to the equilibrium conditions occurring at the bottom and top of the column. Equation 3 assumes that the vapor from the reboiler is in equilibrium with the bottoms product and Equation 9 assumes that the overhead distillate product is totally condensed. Equations assuming other conditions can be readily worked out and applied to the graphical solution.

Bubble Point Charge

If the charge enters the tower close to its bubble point so that (counting from the top down):

$$\overline{L}_{t-1} = F + L_{t-1} \quad . \quad . \quad . \quad . \quad . \quad (13)$$

and

$$\overline{L}_{t-1}\overline{x}_{t-1} = Fx_F + L_{t-1}x_{t-1} \quad . \quad . \quad . \quad (14)$$

then the graphical relationships will be shown on Fig. 4. Here the feed F is added to L_{t-1} coming from the plate above forming $\overline{L}_{t-1}$ which is the total liquid stream reaching the feed plate.

Dew Point Charge

If the charge enters close to its dew point so that:

$$V_t = F + \overline{V}_t \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

and

$$V_t y_t = Fx_F + \overline{V}_t \overline{y}_t \quad . \quad . \quad . \quad . \quad (16)$$

then the graphical relationships will be as shown on Fig. 5, where F is added to $\overline{V}_t$ just above the feed plate to form V_t. Where Equation 13 applies, the charge for the usual case has to be slightly below its bubble point temperature as it will not be at the same temperature as the liquid it mixes with from the tray above the feed. Normally, when two liquids at their respective bubble points which are not the same are mixed, a small amount of vapor will form. This is so even if there is no heat of mixing. Also for similar reasons where Equation 15 applies, the charge for the usual case has to be slightly above its dew point temperature. The graphical representations for other conditions of the feed have been worked out by Bonilla.[2]

Total Reflux

If the column is operating at total reflux, the graphical solution is similar to Fig. 6. Here the feed tray loses its meaning.

If a tie-line coincides with an operating line, infinite trays are required to make a separation. This is illustrated in Fig. 7 with the infinite trays occurring at the feed zone. This example is with the feed at its bubble point.

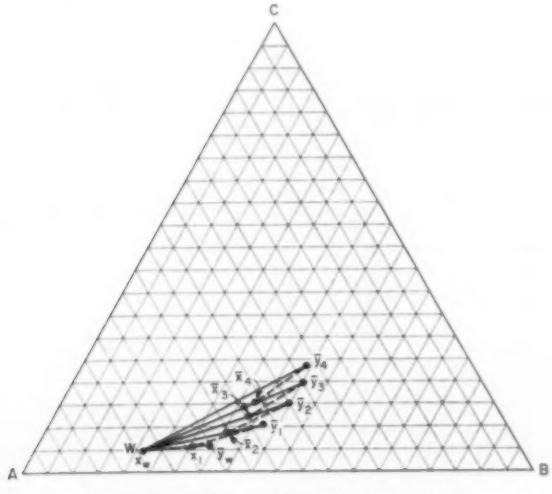


FIG. 2. Bonilla's method — stripping section.

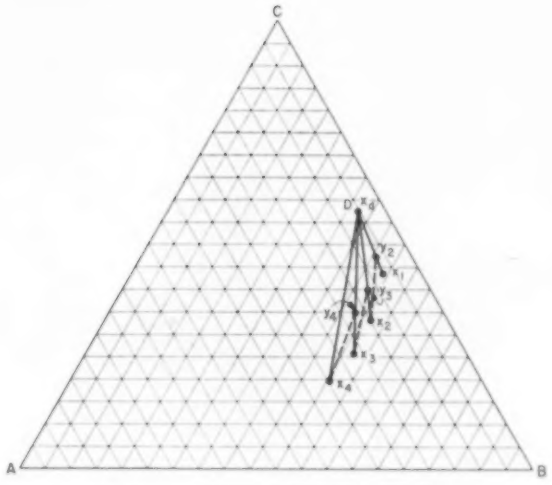


FIG. 3. Bonilla's method — rectifying section.

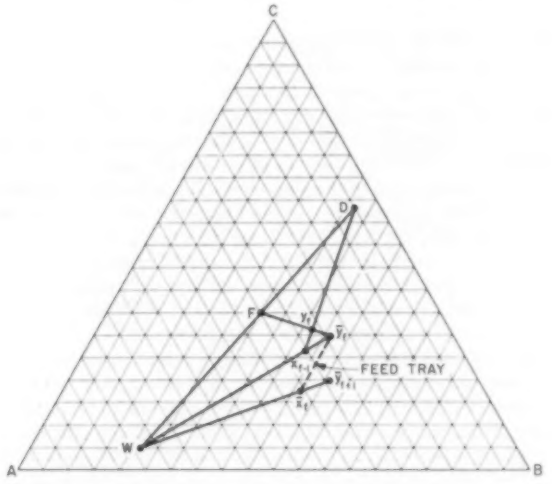


FIG. 4. Bonilla's method — bubble point charge.

Envelope Curve

As determined in the section on Degrees of Freedom, there are four variables that have to be set in order to completely describe the fractionation for a given system and pressure with a particular feed composition and condition. While these four variables may be set in a number of ways, they are frequently set by specifying the composition of a light component in the bottoms product, the composition of a heavy component in the overhead product, the top reflux ratio, and the fourth variable is that the trays are a minimum number to accomplish the required split. In the illustration discussed here this procedure will be followed.

Composition of C will be set in the bottoms and A in the overhead allowing B to be split between the products depending on the reflux and number of trays. Line c on Fig. 8 is the specified concentration of C in the bottoms and the line a, the specified amount of A in the overhead. It is further assumed that the feed will be close to its bubble point so that there will be no change in the vapor rate up

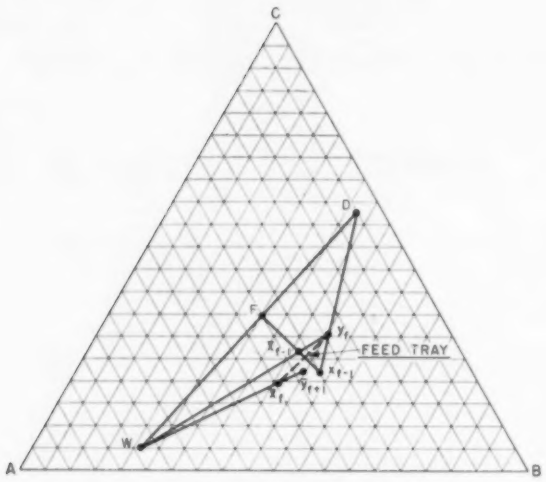


FIG. 5. Bonilla's method — dew point charge.

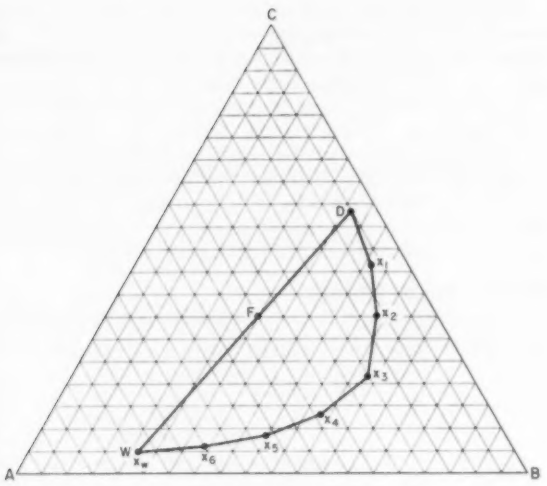


FIG. 6. Total reflux.

the tower at the feed tray. Since two variables are now set, only two variables remain to be set.

For a given reflux ratio the split of B between the overhead and bottoms will vary depending on the number of trays. Maximum variation of B in the overhead and bottoms products is noted on Fig. 8. The line for infinite trays at the top corresponds to the case where there is only a stripping section with infinite trays. This line coincides with the tie-line at D with the feed introduced on the top tray. The line for infinite trays at the bottom corresponds to the case where there is only a rectifying section with infinite trays, and the line coincides with the tie-line at W. Here the vapor feed is introduced underneath the bottom tray. These two cases are not the same as a charge reflux column and a charge reboiled column since in this illustration both the overhead and bottoms compositions are specified. This results in requiring reflux in addition to the charge for the all stripping column and reboiling for the all rectifying column.

The effect of reflux ratio and number of trays on the composition of B in the bottoms now will be explored. If a family of operating lines are drawn through several possible bottoms compositions, W, as shown on Fig. 9, and the point where these operating lines are tangent to a distillation line taken from Fig. 1 is marked off, one obtains a family of lines which represent the loci of these tangent points. Tangent curves are shown dotted. Infinite trays will occur when the liquid composition, $\bar{x}$, on an operating line coincides with a tangent curve.

It may be noted that a bottoms composition between W_2 and W_3 corresponds to the case of infinite trays at the top of the tower with the tangent line (for vapor) going through the overhead composition, D. This will occur at a high L/V since the operating line is long. This is a column with all stripping trays. A bottoms composition between W_1 and W_2 will give a tangent curve that will go through the feed composition, F. Since this means the operating line coincides with the tie-line at F, infinite trays will occur just below the feed point. Refer to Fig. 7.

Similar curves may be obtained starting with different overhead compositions. These curves should correspond to the vapor composition. For the case referred to above with infinite trays just below the feed a corresponding case starting with D can be developed which results in infinite trays just above the feed tray. Since W, F, and D must lie on the same line as the tie-line at F, the case for infinite trays just above the feed is the same one for infinite trays just below the feed. Also a D with more B in it will result in infinite trays at the bottom corresponding to a bottoms composition a little to the left of W_1. This is an all rectifying column. This will occur at a high L/V because the operating

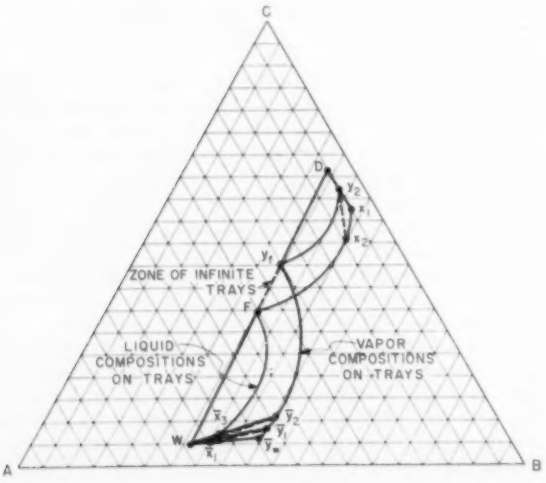


FIG. 7. Infinite trays.

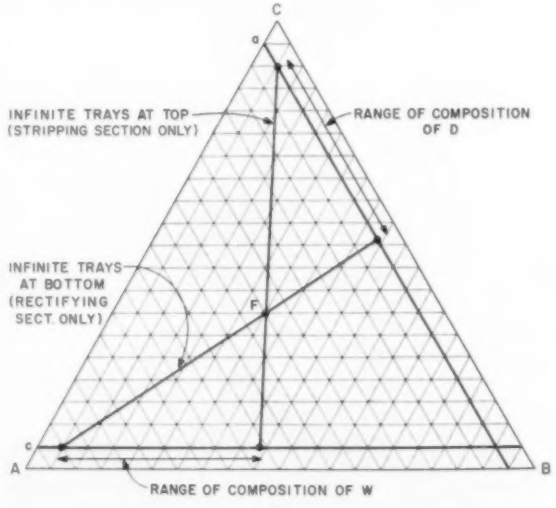


FIG. 8.

line from D will be long. Refer to Fig. 8.

Intermediate choices of bottoms or overhead compositions will result in a certain number of trays being required with a fixed feed tray for a given L/V. This follows from the fact that choosing a definite bottoms or overhead composition, two variables x_a and x_b or y_a and y_b, and the reflux ratio, one variable, and that the total trays be a minimum, one variable, sets the required four variables and the column is accordingly fixed as to number of trays and feed tray. Range of reflux ratios and number of trays for a given W or D are determined by trial and error. Fig. 10 shows a finite case.

Lowest or minimum L/V occurs for the case where infinite trays occur at the feed tray. All other cases result in higher L/V. Range of bottoms compositions for varying L/V and trays is shown on Fig. 11. L/V ratio refers to rates above the feed tray. This is called the envelope curve.

It may be noted in this elementary study that the composition on the feed tray is not the same as the feed composition nor is the ratio of the keys, A and C, necessarily the same. At minimum L/V the feed tray composition is the same as the feed. See Fig. 7. At optimum number of trays the ratio of the composition of the keys on the feed tray usually will not be too different from the ratio in the feed, however.

Choosing the four variables differently than in this illustration will result in a different envelope curve than shown on Fig. 11. Also different types of systems, especially non-ideal will exhibit different envelope curves. This is discussed by White.[1]

The illustration shows the case where all components are distributed between the overhead and bottoms product streams. It has been shown for this case that the minimum L/V occurs when the pinch zone (zone of infinite trays) occurs at the feed tray and that the feed tray composition is the same as the feed. If the feed is at its bubble-point, the feed tray liquid has the same composition as the feed. If the feed is at its dew-point, the vapor from the feed tray has the same composition as the feed.

If the product streams were assumed to be binary mixtures (i.e. having non-distributed components), other zones of infinite trays will occur. Infinite trays occur when the distillation moves from the binary region to the ternary region. If both product streams are assumed to be binary systems, two pinch zones will occur in going from the binary zones to the ternary zone. One occurs above the feed tray and one below. Also if the lowest minimum L/V is specified, another pinch zone occurs at the feed tray as shown on Fig. 7. Thus, more than one pinch zone can occur in multicomponent separation. This is noted by Shiras, Hanson and Gibson.[3] These authors have classified a separation with distributed components in the products as Class I and with non-distributed components as Class II. Different minimum reflux quantities result in each class.

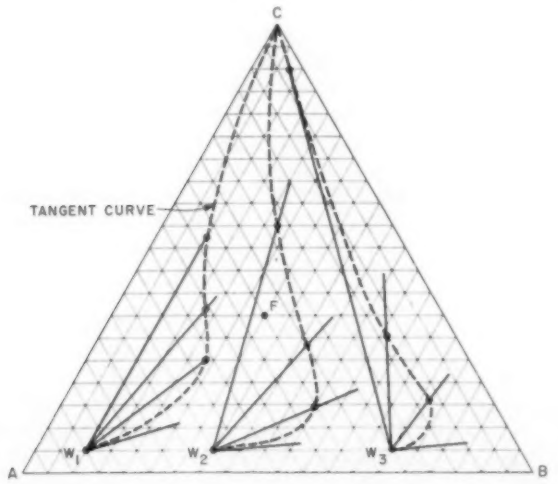


FIG. 9. Tangent curves for liquid.

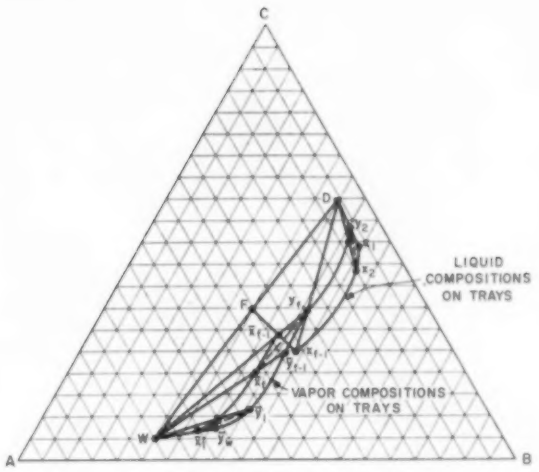


FIG. 10. Finite trays.

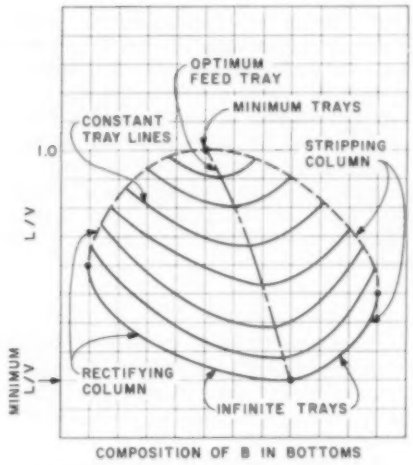


FIG. 11. Range of operating conditions.

Finite Case

As may be seen from Fig. 11 a finite solution to the problem used in the illustration, where A is specified in the bottoms and C in the overhead, must be obtained by trial and error. A fixed L/V is assumed and various bottoms compositions are tried in order to determine the case for the fewest trays. This procedure is time consuming since a match at the feed tray of the tray to tray calculations working down from D and up from W must be made. Only one feed tray choice will exist. Complete equilibrium data in the ternary region must be available to facilitate these calculations.

Non-Ideal Case

The graphical method is awkward and seldom used. The assumptions of constant molal overflow and relative volatility are frequently used to facilitate the tray-to-tray calculations. However, in the non-ideal case at least the constancy of relative volatility cannot be assumed and the equilibrium data must be plotted for easy interpolation. Since both temperature and composition are variables, there is no easy method of plotting vapor-liquid equilibria

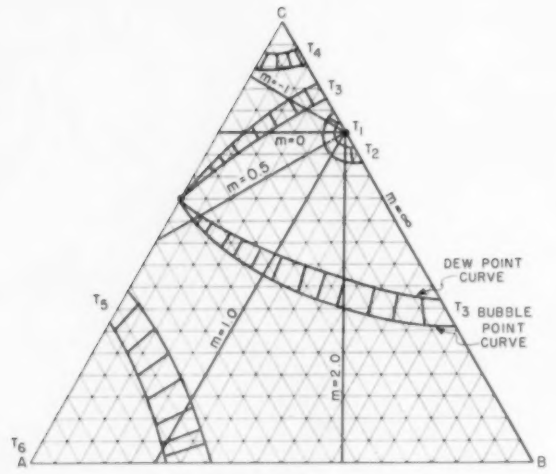


FIG. 12. Hypothetical case.

at a constant pressure for a ternary system. A system with azeotropes present compounds the problem since temperature will not be a simple function of composition. One method of plotting equilibria that avoids the ambiguity of temperature is mentioned in Part I, Chapter 1B. It consists of using a parameter, m, in such a way as to get single constant temperature curves when plotting equilibrium ratios against m. Fig. 12 shows a hypothetical system having two binary azeotropes. The parameter, m, is the family of lines radiating from the lowest azeotrope. It is defined as:

$$m = \frac{x_c' - x_c}{x_a - x_a'}$$

where the prime point refers to the azeotrope at T_1. It will be noted that each line cuts an individual temperature section only once. Fig. 13 shows a typical plot of the equilibrium ratio for the highest boiling component A for the system shown in Fig. 12.

Fig. 14 shows the simple distillation curves for the case shown on Fig. 12. The line, MN, dividing the two zones, I and II, is straight so it cannot be crossed. Hence, in Zone I the point M can be approximated in the overhead product while the bottoms can approach the AB or AC binary systems depending on the composition of the feed which must lie in Zone I. Also A can be approximated in the bottoms product thereby producing an overhead with mainly B and C components.

If the feed lies in Zone II, the products can approach C in the bottoms and an overhead close to the NM line or M can be taken as an overhead product with a bottoms product of mainly A and C components.

Charge Reflux and Charge Reboiled Columns

Charge reflux and charge reboiled columns, especially the former, are so prevalent that a short description of a ternary charge reflux column will be given. A similar analysis can be easily made for a charge reboiled column.

As pointed out before in the section for Binary Distillation a charge reflux or charge reboiled column has two variables to be fixed when the charge condition and composition as well as the column pressure are fixed. Usually the charge is at its bubble-point for a charge reflux column and at its dew-point for a charge reboiled column. This is assumed here. One operating line from W must pass through F and terminate at y_d or D. Then the amount of bottoms product will be given by the ratio of the distances, such that:

$$\frac{W}{F} = \frac{y_d \text{ to } F}{y_d \text{ to } W} \quad . \quad . \quad . \quad . \quad . \quad (17)$$

Choosing a particular bottoms product, W, will completely fix the system since in choosing W, two variables, say x_a and x_b, are thereby fixed. This is all that is necessary to completely fix the system. When W is picked, then there will be only one bottoms yield and a set number of trays that are required. If constant molal overflow can be assumed, then the ratio of the distances between:

$$\frac{y_d \text{ to } F}{F \text{ to } W} = \frac{\overline{y}_n \text{ to } \overline{x}_{n+1}}{\overline{x}_{n+1} \text{ to } W} \quad . \quad . \quad . \quad . \quad (18)$$

One solution is shown on Fig. 15 for the system shown on Fig. 1.

The possible range of bottoms compositions is given in Fig. 16. The boundary curve at the left is the loci of the bottoms tie-lines that would extend through F. This curve represents the case of infinite trays at the bottom. The boundary curve at the right is determined by the tie-line at F and represents infinite trays at the top.

Azeotropic Distillation

Azeotropic distillation is no different from ordinary ternary distillation except that in being a non-ideal system, complete equilibrium data should be available and constant molal overflow and especially constant relative volatility cannot be assumed. Ternary azeotropic distillation is frequently resorted to in order to separate binary mixtures which are either difficult or impossible to separate by ordinary fractionation. In this case a third component called entrainer is added to the binary mixture and forms an azeotrope with one of the binary components. This azeotrope can then be taken overhead in a fractionating column leaving

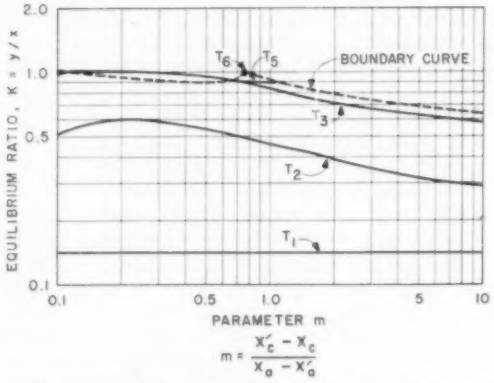


FIG. 13. Equilibrium ratio of compound A from Fig. 12.

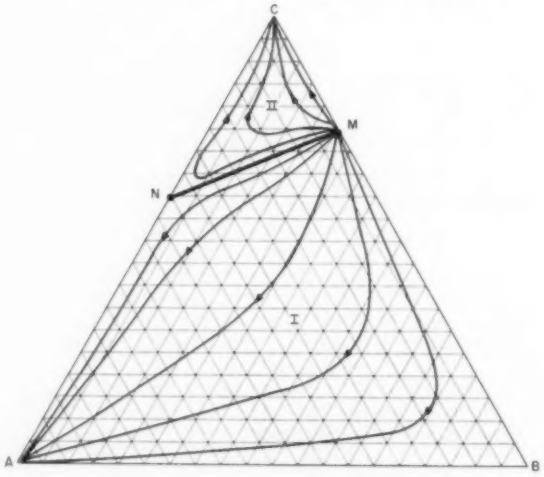


FIG. 14. Distillation curves for Fig. 12.

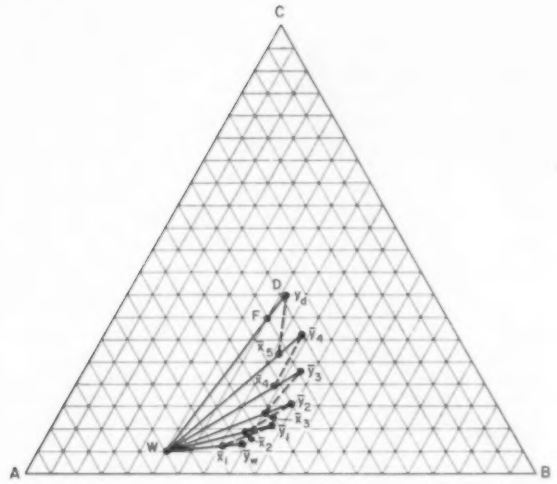


FIG. 15. Charge reflux column.

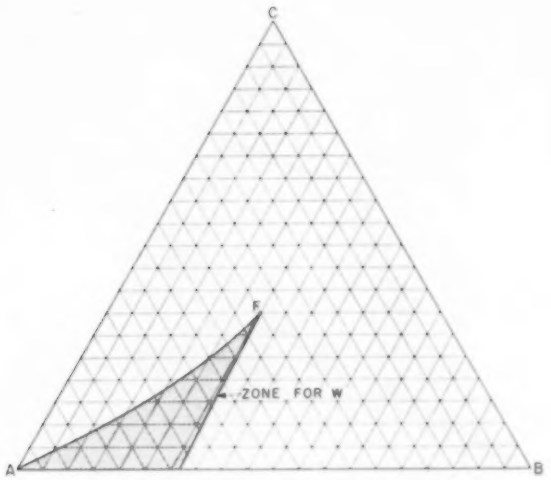


FIG. 16. Range of W for charge reflux.

the other binary component as a bottoms product. Azeotropic distillation is also used for multicomponent separations such as separating aromatics from paraffins. In this case in order to make a sharp separation the aromatic-paraffin mixture is a narrow boiling cut and frequently can be treated as a binary mixture in the fractionation calculations.

The overhead product containing the entrainer and one desired component must be further fractionated to recover the entrainer. If the overhead separates into two liquid phases after condensing, one rich in the desired component and the other rich in the entrainer, the subsequent fractionation to obtain the desired component pure is greatly facilitated. In this case the phase rich in the desired component can be charged to a charge reflux column where the desired component is removed as a pure bottoms product. The overhead product containing the entrainer and appreciable amount of the desired component is recycled to the condenser on the azeotrope tower. This fractionating system is shown in the section on Types of Continuous Distillations.

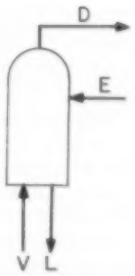
Ternary azeotropic distillation also differs from normal ternary distillation in the method of adding the entrainer to the column. If it is added with the charge, there is no basic difference. It is usually added as reflux and sometimes at other points in the column, even below the feed tray. The proper location will depend on the effectiveness of the entrainer and whether it breaks into two liquid phases in the reflux drum. The location must be determined for each individual case. The location that results in the cheapest installation for a given separation is the proper choice.

To illustrate different modes of adding the entrainer the system shown in Fig. 12 and 14 will be used where B is the entrainer and forms an azeotrope, M, with C. The binary charge will be the binary azeotrope, N, and nearly pure A will be produced as the azeotropic column's bottoms product.

Case 1 represents the separation where the entrainer is added with the charge. This is illustrated on Fig. 17. Enough entrainer has to be added to make the gross charge F. Since both W and D were fixed thereby setting three variables, the reflux ratio has to be chosen before the system is fixed.

Case 2 is where the entrainer is added as reflux. The same overhead product is assumed in both these cases. Development of the material balance equations is based on:

Where E is the pure entrainer used as reflux, D is the gross overhead product, and V and L are the vapor and liquid traffic in the column. Making a material balance around this portion of the column:



$$D - E = V - L \quad . \quad . \quad . \quad . \quad (19)$$

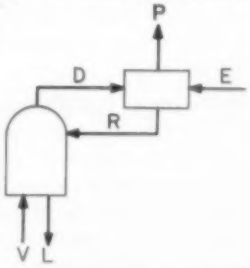
$$Vy_{n+1} = Lx_n + (D - E)\,f \quad . \quad . \quad . \quad (20)$$

where f is the fictitious composition of the net overhead product. Note the similarity between equations 11 and 20. The top operating lines start at f. Since the bottoms product, W, the feed N, and the net overhead product must lie on a straight line, f is determined as shown on Fig. 18. If point f and W are assumed thereby fixing three variables, then D or the reflux still remains to be fixed before the system is fixed. After fixing f and D, the reflux cannot be arbitrarily chosen as it is determined when D is picked. The quantity E or reflux is given by the ratio of the distances between:

$$\frac{E}{D} = \frac{f \text{ to } D}{f \text{ to } E} \quad . \quad . \quad . \quad . \quad . \quad (21)$$

It may be noted that if D lies too close to M (small amount of reflux) the column cannot produce the desired product. No match can be made as the compositions of the top trays will end up in Zone II.

Case 3 is where the entrainer is the heavy phase in the reflux drum and the overhead product is the light liquid phase. The treatment of this case is not quite consistent as the equilibrium diagram, Fig. 12, does not show two liquid phases yet it is assumed the reflux is at its bubble point. Since the overhead stream splits into two liquid phases upon condensation, line MN is really two lines, one for each liquid phase. The development of the material balance equations are based on:



Where E is the makeup of pure entrainer to the reflux drum, P is the overhead product, and R is the reflux to the top. Making a material balance around the reflux drum and the top portion of the column as follows:

$$P - E = D - R = V - L \quad . \quad . \quad . \quad (22)$$

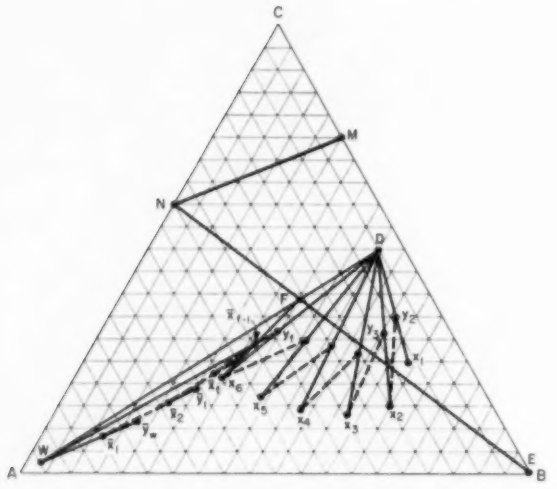


FIG. 17. Azeotropic distillation — entrainer with feed.

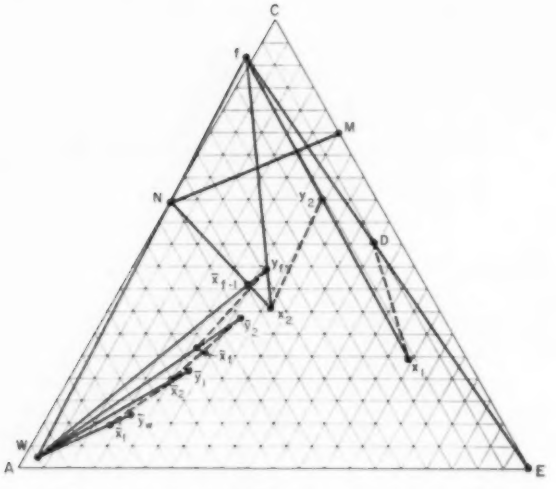


FIG. 18. Azeotropic distillation — entrainer as reflux.

$$(P - E)f = Dy_d - Rx_R = Vy_{n+1} - Lx_n \quad . \quad . \quad (23)$$

Here again f is the fictitious composition of the net overhead product. The workup of this case is shown on Fig. 19. Concentration at points P and R are assumed.

Where the entrainer is miscible with the condensed overhead product, the entrainer is usually injected with the charge as shown on Fig. 17. However, less entrainer would be used thereby producing an overhead product closer to M. This would greatly ease the separation and less trays would be required in the rectifying section. This can be inferred by the nearly straight distillation curve in the center of Zone I on Fig. 14.

If the miscible entrainer is used as reflux as shown on Fig. 18, D cannot lie close to M. If it did, no match at the feed tray could be made as the tray composition in working down the column from f would eventually land in Zone II. Consequently, large amounts of E must be distilled overhead to overcome this tendency.

However, if the overhead separates into two liquid phases, P and R, as shown on Fig. 19, the entrainer rich phase is used as reflux. This is usually preferable to adding it to the charge. Here the overhead product is P and it is actually leaner in entrainer than even the azeotrope, M. Using the entrainer as reflux reduces the number of trays required in the rectifying section from that required if entrainer is added to charge.

It should be noted that in all the above three cases the stripping section is nearly the same.

Thorough references are non-existent. The better ones[4,5] are given. These give the requirements for a good entrainer which need not be given here.

Sometimes the fractionation calculations are made assuming a binary system composed of a fictitious component equal to the CBM and the pure bottoms product. This would be rigorous only if the distillation curve from M to A is straight and the fractionation is carried out along this one curve.

Extractive Distillation

Whereas the azeotropic distillation deals with an entrainer that distills overhead with one of the components in the charge, in extractive distillation the added component, called solvent, carries one of the components out the bottom. It is used also in multicomponent separations where the feed has a narrow boiling range. A typical extractive distillation unit consisting of an extraction column and solvent recovery column is shown in the section on Types of Continuous Distillations.

The extraction tower is divided into three sections. The top section above the solvent entry is the solvent knockback section, the section between the solvent entry and the feed point is the true rectifying section and the stripping section is below this. The presence of the liquid solvent on the trays changes the relative volatilities of the feed constituents, thereby making it easier to separate them. The rectifying section can also be thought of as an absorbing section.

The illustrative system is shown on Fig. 20. The binary AC system is the same as for Fig. 12 and 14. Component B is the solvent and boils above either A or C. It boils sufficiently above C so that it can be easily separated from C by distillation. It also does not form azeotropes with either of the other components. The peculiar shape of the distillation curves along the bottom of the graph indicates that the solvent has made A more volatile with respect to C in this region.

The material balance equations around the knockback and stripping sections are the usual ones and they need not be given here. Development of the material balance equations around the rectifying section is based on the sketch and is:

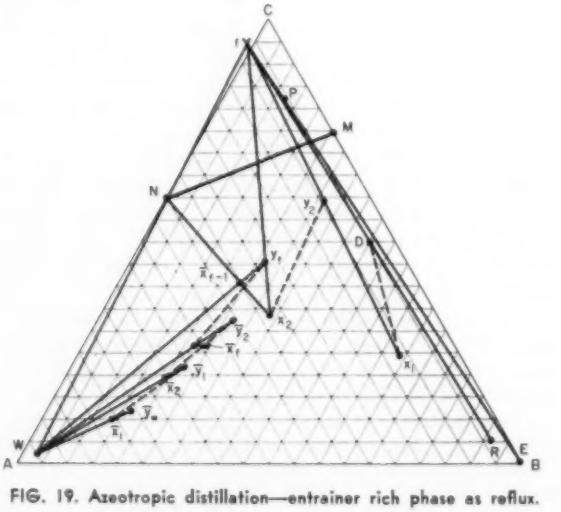
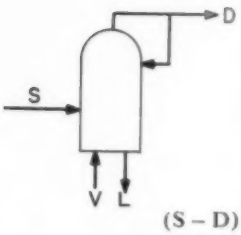


FIG. 19. Azeotropic distillation—entrainer rich phase as reflux.



$$S - D = L - V \quad . \quad . \quad . \quad (24)$$

$$(S - D)f = Lx_n - Vy_{n+1} \quad (25)$$

where S is the solvent in and f is the net overhead product. Usually S is larger than D as is indicated in the above equations.

Also:

$$(S - D)\,f = Wx_w - Fx_F \quad . \quad . \quad . \quad . \quad (26)$$

$$(S - D)f = S - Dy_d \quad . \quad . \quad . \quad . \quad (27)$$

In the rectifying section L/V is given by the ratio of the distances.

$$\frac{L}{V} = \frac{y_{n+1} \text{ to } f}{x_n \text{ to } f} \quad . \quad . \quad . \quad . \quad . \quad (28)$$

Since the solvent concentration on the rectifying trays is normally fixed, the reflux is thus fixed indirectly leaving three variables left to be chosen. These may be fixed in a number of different ways, one of which might be: Composition of one component in the overhead and another in the bottoms, and the number of trays in the rectifying section. The quantity and condition of solvent is fixed before-hand like a feed stream. Separation is shown on Fig. 21. Solvent is introduced hot so as to minimize inducing reflux of material other than solvent. It will be noted that in the rectifying section the solvent concentration is nearly constant. It is important to control this concentration at a desired point because the relative volatility of A to C varies with solvent concentration. The feed usually is charged all vaporized in order to keep the solvent concentration up. As noted the reflux quantity, solvent quantity and temperature and feed condition are important in controlling the solvent concentration on the rectifying trays.

Methods of calculating the trays and reflux are given in the references.[4-8] One short-cut method used is to do the usual fractionation calculations on a solvent free basis adding a few trays for the knockback section. These references also give the desired qualities of the solvent.

In general extractive distillation is more flexible than azeotropic and different mixtures can be separated with the same solvent. Also for a desired separation it is easier to find a satisfactory solvent.

Fractionation Near Critical Point

When fractionating in the vicinity of the critical region, good equilibrium data and accurate knowledge of the critical region must be available. Some separation is possible close to the critical point, but a good split is usually impossible. This is due not entirely to the limitations resulting from the critical point but is caused also by poor tray efficiencies. Since the densities of liquid and vapor are close together, entrainment is important and high liquid heads obtain on the trays causing poor vapor distribution. The trays must be overdesigned.

Fig. 22 shows a system that will be used to illustrate fractionation near the critical region. Binary system, AC, has a minimum critical point at N (see Fig. 8, Part I, Chapter 1A). Binary system, BC, has a maximum critical point at M (see Fig. 4, Part I, Chapter 1A). The binary system, AB, is below the critical region. Component B is lower boiling than component A. Point P represents where the limiting tie-line at the critical point is tangent to the critical point curve. This is not so at any other place along the critical curve, and there results a zone between the critical curve and C where a saturated vapor or liquid phase can exist.

Fig. 23 shows the distillation curves for the system given in Fig. 22. As may be noted some distillation curves either end in the critical zone or begin on the critical point curve.

Fig. 24 shows a separation for this system. It should be noted that even though the charge and products are away

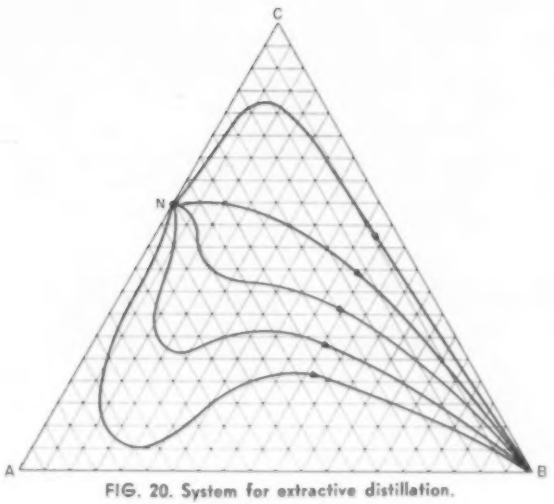


FIG. 20. System for extractive distillation.

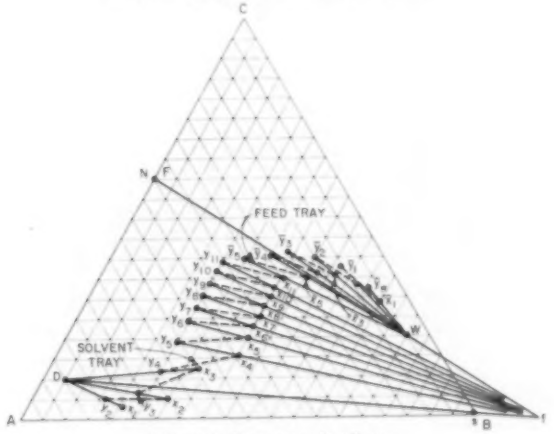


FIG. 21. Extractive distillation.

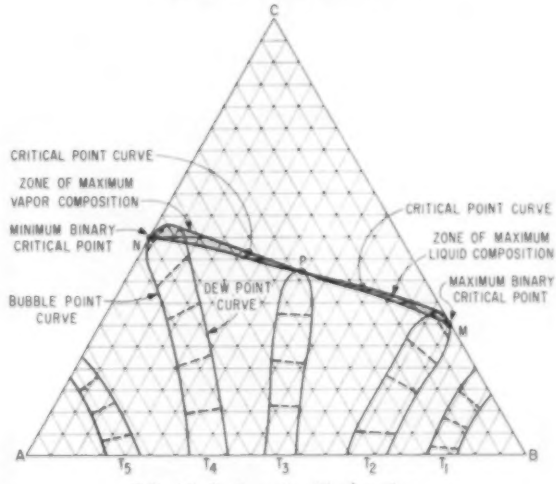


FIG. 22. System at critical region.

from the critical region, there may be a zone in the column that may approach closely the critical region. Comparing with Fig. 5 note the feed is at its dew-point.

Two Liquid Phase Fractionation

The case where the charge and product streams are two liquid phases or a liquid phase in equilibrium with another liquid phase offers some interesting variations to the previous discussions. Since the fractionation is being kept within the three phase region, it can be graphically solved

by a Ponchon type of plot. Fig. 25 is a plot of the three phase region of Fig. 7, Part 1, Chapter 1B Phase Equilibria. The liquid-liquid tie-lines are shown dashed and the vapor-liquid tie-lines are dotted. C′ is the three phase critical solution point.

In the illustration it is assumed that the composition of the overhead is chosen on the liquid saturation curve, thereby setting two variables; also that the bottoms product is on the saturation curve. Thus, three variables are fixed. If all of the liquid phase in equilibrium with the overhead product phase is used only as reflux, the last variable is set. Now the column is completely fixed, and the solution can give only one value for the number of trays required. The illustration shows the case for a feed at its bubble-point.

Some of the symbols used on Fig. 25 are:

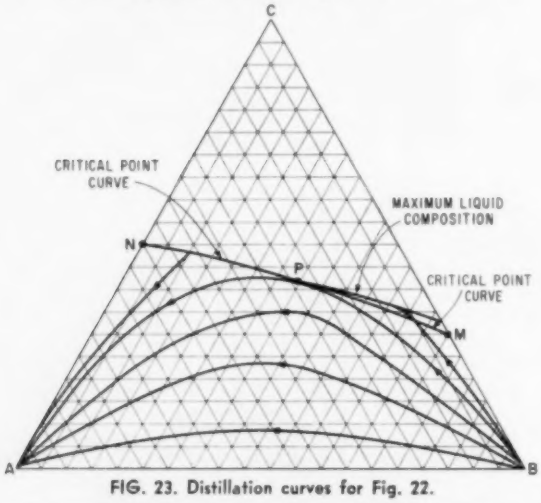


FIG. 23. Distillation curves for Fig. 22.

SOLENOID VALVES OF TEFLON*

for additives, sampling systems, batch testing, analyzers!

*DuPont Company registered trademark.

Valcor's solenoid valves of Teflon are perfect for a wide variety of chemical processes requiring **absolute freedom from contamination!** The molded body and diaphragm of Teflon is chemically inert and **corrosion-resistant to virtually every medium.** Valcor solenoid valves outlast and outperform steel! Available in hundreds of sizes and pressure ratings... immediate delivery. Write today for free 16-page booklet telling how to select solenoid valves for over 500 corrosive media!

VALCOR SOLENOID VALVES

VALCOR ENGINEERING CORP.

5357 Carnegie Avenue • Kenilworth, N. J. • CH 5-1665

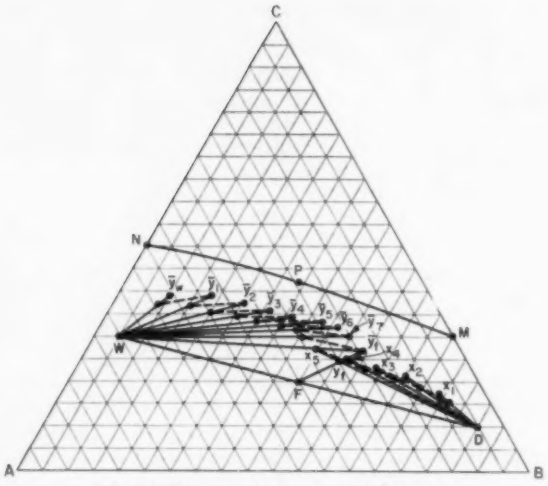


FIG. 24. Fractionation near critical region.

x_R = composition of the reflux
x' = composition of the liquid phase rich in A
x° = composition of the combined liquid phase on each plate.

The other symbols are the same as used in the previous illustrations.

Material balance equations giving the operating lines radiating from D and W are similar to those given before. They also give the following relationships related to the ratio of the distances:

$$\frac{L}{V} = \frac{y \text{ to } D}{x^\circ \text{ to } D} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (29)$$

$$\frac{L}{V} = \frac{y \text{ to } W}{x^\circ \text{ to } W} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (30)$$

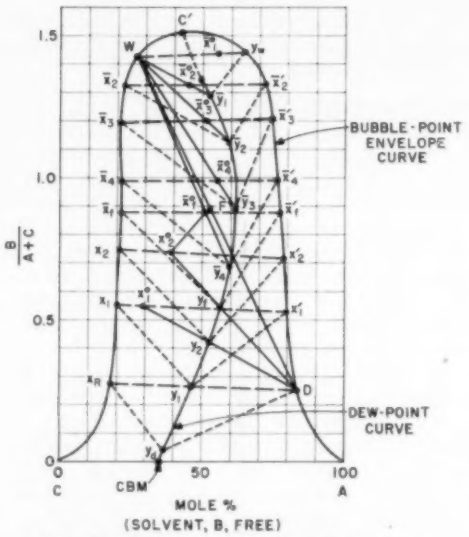


FIG. 25. Distillation in the three phase region.

References

1. White, R. R., *Pet. Proc.*, 8, 357, 539, 704, 892, 1026, 1174, 1336, 1533, 1705 (1953).
2. Bonilla, C. E., *Trans.* AIChE, 37, 669 (1941).
3. Shiras, R. N., Hanson, D. N., and Gibson, C. H., I&EC, 42, 871 (1950).
4. Benedict, M., and Rubin, L. C., *J. AIChE*, 41, 353 (1945).
5. Robinson, C. S., and Gilliland, E. R., Elements of Fractional Distillation, 4th Ed., McGraw-Hill Book Co., New York (1950).
6. Chambers, J. M., *Chem. Eng. Prog.*, 47, 555 (1951).
7. Atkins, G. T., and Boyer, C. M., *Chem. Eng. Prog.*, 45, 553 (1949).
8. Dunn, C. L., Millar, R. W. Pierotti, G. J., Shiras, R. N., and Souders, M., Jr., *Trans.* AIChE, 41, 631 (1945).

From Du Pont...TETRAMIX* for greater refining flexibility

In the brief few months since the introduction of Du Pont TETRAMIX* antiknock compound, refiners have found that it offers a new degree of flexibility in their choice and use of lead antiknocks. For example, while its effectiveness varies with gasoline composition (as is true with other antiknocks as well), TETRAMIX is generally effective in low, medium and high dosages.

Results of tests to date indicate that TETRAMIX is also a more effective antiknock in some fuels than either tetraethyl or tetramethyl lead —that is, a given octane number can, in such fuels, be obtained with lower concentrations of TETRAMIX than with TEL or TML.

Based on this refining flexibility and the potential savings it offers in blending, TETRAMIX antiknock compound has already won refiners' acceptance. With commercial quantities available, now is the time for *you* to investigate the potential advantages of TETRAMIX.

Because you have a choice of all three major lead antiknocks at Du Pont, you'll get impartial help in selecting the best one for *your* gasoline stocks. Your Du Pont Petroleum Chemicals Division representative can assist you in evaluating the relative merits of TEL, TML and TETRAMIX.

E. I. du Pont de Nemours & Co. (Inc.), Petroleum Chemicals Division, Wilmington 98, Delaware.

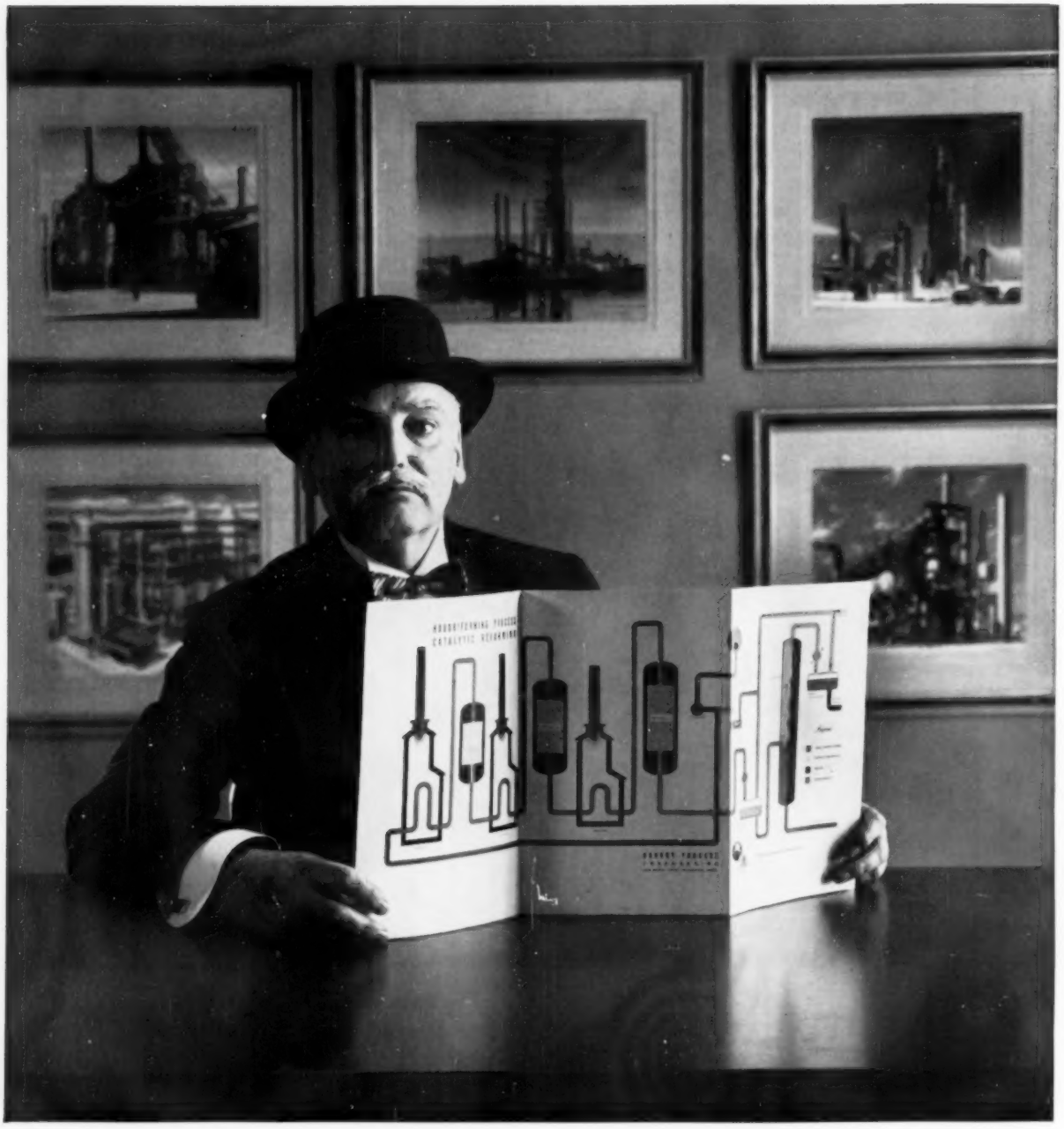
*Trademark

DU PONT

REG. U.S. PAT. OFF.

Better Things for Better Living
. . . through Chemistry

Lead Antiknock Compounds *and other* PETROLEUM ADDITIVES



PETROLEUM PROCESSES PLANNED FOR YOUR PROFIT

The wide range of HOUDRY processes offers a selection of routes to maximum yields and highest product quality from many different grades of petroleum raw materials.

Two examples: the HOUDRIFLOW catalytic cracking process converts any fraction between naphtha and asphalt—from either sweet or sour crudes, liquid or vapor feed—to high octane gasoline; HOUDRIFORMING produces extremely high yields of high octane gasoline, blending stocks, and aromatics from straight-run and cracked petroleum naphthas. HOUDRY processes also include DEHYDROGENATION and DESULFURIZATION. Over the full range of catalytic processing, HOUDRY supplies not only basic experience in process design, but commercially-proved services as well—in catalysts, research, engineering...and economic consultation.

*HOUDRY
PROCESS CORPORATION
1528 Walnut Street, Philadelphia 2, Pa.
*Houdry means Progress...through Catalysis

FOR FURTHER INFORMATION ON
ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Here's your Product & literature Index for April

Add years of life . . . to stacks, boilers, engines, mufflers, manifolds, exhausts, hot air pipes . . . with Sili-Kool, new silicone-base aluminum paint. Details are given in new bulletin. *C. H. Dragert Co.*

Circle number (41) on reply card.

Ammonia production via steam reforming . . . is discussed in illustrated brochure that gives direct operating costs and utility unit costs in five major geographical sections of the U. S. Contains process descriptions and flowsheets for the basic ammonia process and for both 1-stage and 2-stage steam reforming operations. *M. W. Kellogg Co.*

Circle number (42) on reply card.

Armored flowmeter Model 10A2147 . . . a glass tube, variable area, indicating flowmeter for high pressure and temperature service . . . is detailed in new specification sheet. Gives materials of construction, mounting, scales, capacities, and dimensions. *Fischer & Porter Co.*

Circle number (43) on reply card.

Automatic detection . . . of presence of gasoline and other floating explosive chemicals in dock waters . . . is provided by new Peerless gas-vapor monitor system. Also detects presence of gases in the air, on ground, or in suspension in water. Can be used to record and warn of their presence at various remote points in refineries and petrochemical plants. *Petroleum Instrument Co.*

Circle number (44) on reply card.

Automatic valveless gravity filter . . . greatly reduces problem of silt in cooling water, thus improving operation and easing maintenance. No electrical, mechanical, or human supervision is necessary. Adapts automatically to variations in silt content without aid of any instrumentation or additional equipment. *The Permutit Co.*

Circle number (45) on reply card.

Bronze gate valve . . . the "Compact" Model 300 . . . is described in Bulletin 103. Unit has 125-lb water working pressure rating. Available in ½, ¾, 1, 1¼, 1½, and 2-in. sizes. *American Valve Manufacturing Co.*

Circle number (46) on reply card.

Change charts in 1/10 sec . . . with Dial-O-Graph automatic chart changer. Simple 3-piece attachment fits all recorders. Charts dial off instantly, so there is no interruption of recording. *Mullins Mfg. Co.*

Circle number (47) on reply card.

Closed circuit television monitors . . . have expanded brightness range that fits them for operation in areas of high ambient light. Accessory polarized safety glass faceplate is available for additional effectiveness in minimizing reflections and improving contrast ratio. Monitors are capable of three times the picture quality of home sets, but are simpler to maintain and adjust. *General Electric Co.*

Circle number (48) on reply card.

Compact block heat exchanger . . . made of Karbate impervious graphite . . . provides true counterflow. Fluid flow on both sides of new Type CFB exchanger contacts impervious graphite only. Thus units can be used for heat transfer between corrosive liquids and gases as well as for the more conventional heating or cooling of corrosive solutions with steam or water. *National Carbon Co.*

Circle number (49) on reply card.

Components . . . for Model 184-B process vapor fractometer . . . are detailed in new series of data sheets. Described are sensing units, programmer chassis, pneumatic control accessory, building block sampling systems, and column materials available for various process stream applications. *Perkin-Elmer Corporation.*

Circle number (50) on reply card.

Copper and copper alloy rods and sections . . . are detailed in 48-page booklet containing extensive technical data. *Imperial Chemical Industries Limited.*

Circle number (51) on reply card.

Corexit . . . prevents internal corrosion in pipe still overhead, distillation towers, vapor recovery systems, and other refining units. Extends equipment life, permits longer runs between turnarounds, and reduces down time. *Humble Oil & Refining Co.*

Circle number (52) on reply card.

Corrosion problems in petrochemicals or refining? . . . Don't pass up new 30-page report "Data for Cost Estimation." It gives engineering and cost information for 16 essential items of equipment manufactured under trade name of "Impervite" —impervious graphite material for corrosive conditions up to 340 F and 200 psi. *Falls Industries, Inc.*

Circle number (53) on reply card.

. . . one of a series presented by Western Supply Company, Tulsa, to improve the "I. Q."* of engineers . . . (*"Income Quotient")

TRAIN YOURSELF AND OTHERS IN SUPERVISORY TECHNIQUES FOR PROFESSIONAL ADVANCEMENT

Popular thinking on any subject is often like a pendulum, swinging forward in sheer exhilaration over an exciting idea, then backward to a cynical attitude against it. Years ago, health columnists extolled the nutritive qualities of spinach. Shortly thereafter, it was equally popular to decry spinach as an over-glamorized weed.

This vacillation springs from the efforts of spokesmen to capture interest, and the tendency of many people, like wild creatures in the forest, to give attention to whatever is moving regardless of the direction. That is why it sometimes seems that the more preposterous an idea the more credence it receives.

After World War II, supervisor and management development became extremely popular. Some of these programs naturally fell short of expectations, and there are always detractors — ready to display their intellectual brilliance by speaking cynically of *all* types of human relations training. Real progress in supervisory methods has, therefore, been slow.

Supervisory personnel, continually aware of the intrinsic values of human relations, are the key to uninterrupted production, completion of projects successfully and on time, for they forge the links in the productive chain solidly together.

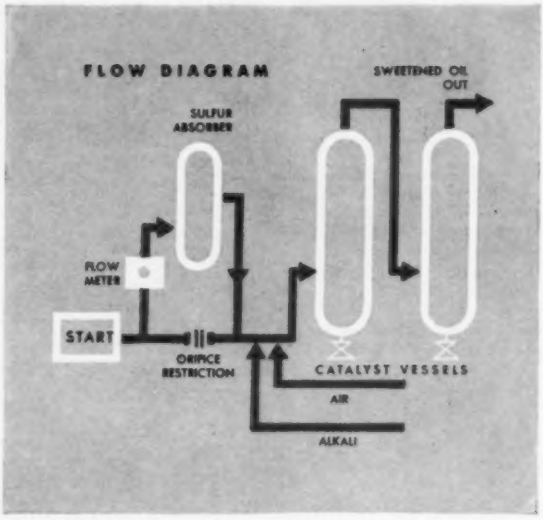
Your management is interested not only in the creative, bold steps you would take into unknown solutions to problems, but also in how quickly and productively (profitably) you can put these ideas into practical application. When the solution, or idea, leaves your desk and starts down the long line of being put into practice, the supervisors throughout that chain of action will determine to a great extent whether their individual components will function properly or whether a project will bog down under the weight of misunderstanding and apathy.

It is extremely important, therefore, to maintain good supervisory practices throughout the various departments through which the original concept must be translated. It means a thorough understanding of human relations yourself, and the ability to communicate this understanding and appreciation to the supervisory personnel under you. This can and probably must be done both by individual contact with your supervisors and/or by conducting actual courses of study on the subject.

FOOTNOTE: the foregoing paragraphs are a direct quotation from another of Western's "personal-professional development" series. Booklet E-7, titled "Supervision — for Professional Advancement" a copy of which is yours upon request, without obligation. Write to WESTERN SUPPLY COMPANY, HEAT EXCHANGER DIVISION, P. O. Box 1888, Tulsa, Okla. — **where supervision contributes greatly to the manufacture of heat exchangers of the highest quality, and where personal attention to detail is our watchword.**

PRODUCT IMPROVEMENT WITH

PETRECO



IF SWEETENING IS ONE OF YOUR REFINERY PROBLEMS...

these facts about PETRECO* BENDER Catalytic Sweetening† may show you the answer:

LOW OPERATING COSTS: The average treating costs of Petreco Bender treating units are about 0.5 cents per barrel. Copper chloride or doctor treating costs, exclusive of amortization, generally exceed 1.0 cents per barrel. *The value of the volume loss in doctor treating alone often exceeds the total operation and amortization costs of Petreco Bender catalytic sweetening.*

SWEET NON-CORROSIVE PRODUCT: As compared to doctor treating, less sulfur is used, resulting in the delivery of a consistently non-corrosive product. *The use of less sulfur also lessens octane loss.*

ELIMINATES AIR AND WATER POLLUTION: Processing is in a closed system, eliminating air pollution and the attendant safety hazards. This eliminates open batch type agitators, thereby assisting in safety programs. *There is no "black strap" carry-over or carry-under to contaminate waste disposal systems.*

The product from the Petreco Bender unit is low in trace metal ions. Where a water wash is required to meet local product specifications, emulsion problems are not encountered due to the cleanliness of the Bender treated oil.

The only spent alkali withdrawn from the Bender unit each day is the small amount not consumed in the process.

HIGH YIELD: There is no volume loss in the system other than sampling and spillage. The volume loss in other sweetening processes is the greatest expense factor.

CONTINUOUS REGENERATION NOT NECESSARY: The catalyst retains its activity for long periods of time. This is made possible by the continuous addition of small quantities of air and alkali. Catalyst life without reactivation is usually two years or more. *Two Petreco Bender plants have been operating for over three years without any reactivation of the original catalyst.*

LOW INSTALLATION COST: *Unit cost for new equipment is comparatively low, ranging from $15 to $30 per barrel of daily throughput capacity.* If existing vessels are available and appropriate for conversion, this cost can be substantially reduced. Very often the charge may be taken directly from a distillation unit with existing pumps, exchangers and instrumentation, reducing the installation cost further.

SMALL TREATING AREA REQUIRED: Where ground areas are congested, the area occupied by any treating unit is of great importance. The plot dimensions for a 5,000 bpd Petreco Bender unit, for example, would be approximately 20′ x 35′.

† *For middle range distillate streams such as kerosine, stove oil, light gas oil, No. 2 fuel oil, coker naphtha and catalytic gasoline.*

*PETRECO *is a registered trademark of Petrolite Corporation.*

B-60-2

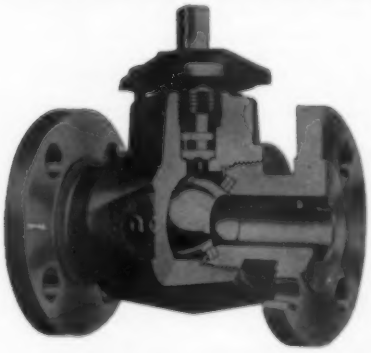
PETROLITE CORPORATION

SUBSIDIARY AND AFFILIATED COMPANIES
CANADA, Edmonton, Alberta • ENGLAND, London
GERMANY, Frankfurt, a. M. • VENEZUELA, Caracas

PETRECO DIVISION
3202 South Wayside Drive (P.O. Box 2546), Houston 1, Texas
1390 East Burnett Street (P.O. Box 7216), Long Beach 7, California

REPRESENTATIVES
ARGENTINA, Buenos Aires • BRAZIL, Rio de Janeiro • COLOMBIA, Bogota
ITALY, Rome • JAPAN, Tokyo • KUWAIT, Kuwait • MEXICO, Mexico, D. F.
NETHERLANDS, The Hague • PERU, Talara • TRINIDAD, Port of Spain

LEAKPROOF AFTER 600,000 CYCLES!



Proved in the laboratory, and in over five years of field service with such difficult ladings as acetone, propane, vinyl chloride, and lime and soda-ash slurry, W-K-M's ACF Ball Valve has earned a reputation for extra long life *without lubrication.* For example —

In one test, W-K-M opened and closed a 2″ standard production model under pressure 600,000 times. The valve still sealed tight, and there was no measurable wear on either the chrome-plated ball or the Teflon seats!

W-K-M's rugged ACF Ball Valves are available in carbon steel to ASA 300 lbs. (some sizes 600 lbs.), and in semi-steel, ASA 200 and 400 lbs. WOG.

Write for Catalog 1000.

Conduit is full-bore; Teflon stem gaskets and seats are sealed from the lading flow.

WHEN SO MUCH DEPENDS ON A VALVE . . . SPECIFY ACF BALL VALVES

W-K-M

DIVISION OF ACF INDUSTRIES
INCORPORATED
P. O. BOX 2117, HOUSTON, TEXAS

6006

Gas-engine-driven compressor . . . Model TBA . . . is new modified version of popular Model TLA. Available in five, six, eight, and ten power cylinder models rated at 1500, 1800, 2400, and 3000 bhp respectively. Has 17 by 17-in. bore and stroke. Turbocharger system coupled with new automatic ignition timing control makes the TBA ideally suited for variable speed-variable load applications. *Clark Bros. Co.*

Circle number (72) on reply card.

Metering pumps and packaged tank units . . . Series 100 . . . are catalogued in new bulletin. Pump capacities range from .95 gal per hr vs 1200 psi, to 50 gal per hr vs 100 psi, at repeatable accuracies within ±1%. *Wallace & Tiernan Inc.*

Circle number (73) on reply card.

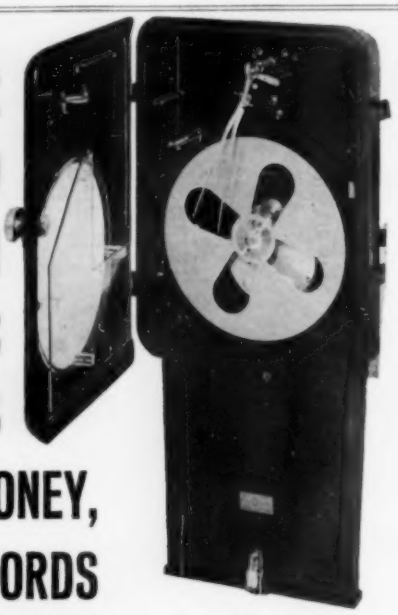
Metex Xtra-dense mist eliminators . . . when installed in scrubbers and knock-out drums will dry natural gas to less than 0.1 gal entrained liquid per MMcf. *Metal Textile Corp.*

Circle number (74) on reply card.

Multi-point detection and alarm of hazardous combustible gases . . . is obtained with Model 520 Multitector. Detection is performed by sensing elements located at the desired points or areas and connected to the central unit by cables which can be up to 1500 ft long. Each detection point has its own measuring circuit, indicator, and adjustable alarm. Unit is electrical in nature, having neither tubes nor transistors. *Houston Instrument Corp.*

Circle number (75) on reply card.

CONVERT YOUR RECORDERS TO DIAL-O-GRAPH AUTOMATIC CHART CHANGERS ...SAVE TIME, MONEY, GET BETTER RECORDS



With Dial-O-Graph, you can fully automate your recorders so that they will operate completely unattended . . . day and night . . . for hours, or weeks — with the charts changed automatically. Recorders in an entire plant or system can be synchronized so that the charts change at exactly the same time — an advantage virtually impossible with manual chart-changing. Personnel problems are reduced, recording data is more accurate and reliable, and accounting records are better.

Dial-O-Graph adapts to any make, model, or type of recorder. Any standard circular chart can be used, modified only with a single slot in the center, the same slot pattern for all instruments and all change times. Charts are group-loaded on the chart plate, as many as 50 at a time if desired. Dial-O-Graph charts stack, handle, and integrate as usual.

Long used by most major gas companies, Dial-O-Graph is the field-proven, better way to change charts. The fastest, most efficient, and dependable chart changer available, you get more value and more features in Dial-O-Graph than in any other method.

Whether you have one or one hundred recorders, Dial-O-Graph is worth your investigation. Write for illustrated literature and a list of users in your area. There's no obligation, of course.

MULLINS

Dial-O-Graph

AUTOMATIC CHART CHANGER

MULLINS MFG. CO., INC. • 3311 WEST DAVIS • DALLAS 11, TEXAS

Cryogenic pump . . . new hydraulically driven high pressure reciprocating unit . . . requires a minimum suction head. Suitable for stationary or truck mounted installations. Available in sizes from 5000 to 30,000 std cu ft per hr. *American Messer Corp.*

Circle number (54) on reply card.

Dalpac 4 antioxidant . . . Hercules 2, 6-di-tert-butyl-p-cresol . . . inhibits gum formation, stabilizes gasoline color, and helps maintain engine cleanliness. Prevents deterioration in turbine and transformer oils and does not affect electrical properties. *Hercules Powder Co.*

Circle number (55) on reply card.

Design economics of heat exchangers . . . are treated in new booklet "Cost Engineering." Stresses importance of long-range forecasting. Outlines qualifications of the cost engineer. *Western Supply Co.*

Circle number (56) on reply card.

Dripless dripstick . . . accurately measures liquid contents of any container. Mounted top or bottom, the indicator remains hermetically sealed. Extended calibrated rod is easily read as it pops out of sealed container. *Flight Refueling, Inc.*

Circle number (57) on reply card.

Emergency lighting unit . . . the automatic Lightguard Model D . . . operates instantaneously if normal power fails and shuts itself off when power is restored. Powered by a 9-v dry-cell battery, the unit can be installed and left unattended for the entire service life of the battery. Gives up to 3¼ hours of emergency lighting with one lamp and provides 1½ hours of protection with two lamps. *Exide Storage Battery Co.*

Circle number (58) on reply card.

Emergency pipe clamps and collar leak clamps . . . are among repair items for steel and cast iron pipe detailed in catalog. *M. B. Skinner Co.*

Circle number (59) on reply card.

Flame ionization micromalyzer . . . a high-speed, high-resolution, and high-sensitivity gas chromatograph . . . is discussed in new data sheet. Unit is supplied complete with semi-micro packed columns. *Hallikainen Instruments.*

Circle number (60) on reply card.

Flo-Eye . . . new low-cost sight flow indicator . . . lets you take a look inside your line to determine if there is flow and the direction and condition of the fluid. Retains most features of company's high-pressure, high-temperature models, having double sight glasses for clear observation of fluid even under poor lighting conditions. *Schutte and Koerting Co.*

Circle number (61) on reply card.

Forged chrome moly steel strainer . . . is designed for 2500-psi pressure at temperatures to 1050 F and is suitable for 6000 psi at 100 F. Available in two sizes and four pipe connections: 26 lb, ¾ or 1 in., and 56 lb, 1¼ or 1½ in. *Armstrong Machine Works.*

Circle number (62) on reply card.

Fractional horsepower Duty Master motor . . . is explained in Bulletin B-2514. *Reliance Electric and Engineering Company.*

Circle number (63) on reply card.

REACTS WITH THE STEEL...

...eliminates underfilm corrosion in finished product tanks

HUMBLE RUST-BAN® 190

This remarkable new coating bonds so perfectly to steel that you cannot discover an interface! The reason? Humble RUST-BAN 190 reacts *chemically* with the steel. The resulting bond is inseparable . . . completely eliminating underfilm corrosion.

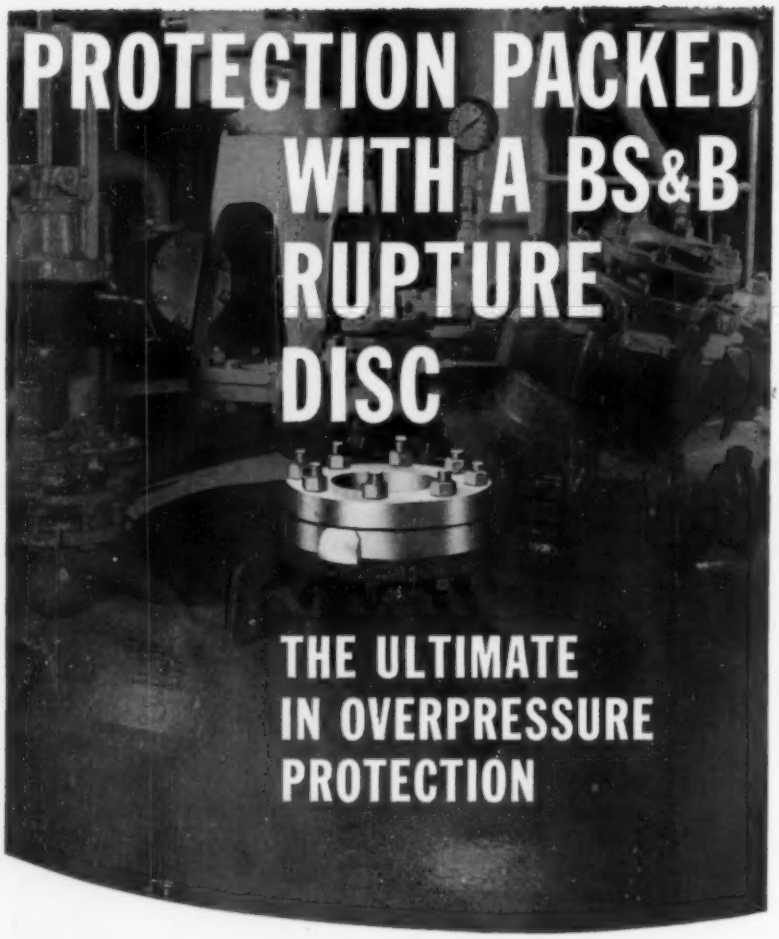
The hard, abrasion-resistant coating of 100% inorganic zinc silicate is virtually impervious to the scraping action of floating roofs. RUST-BAN 190 is nonflammable, does not contaminate even high-purity products.

When properly applied and cured (with its companion RUST-BAN 195) RUST-BAN 190 provides many years of protection at far lower annual cost than any other type of coating!

For complete information about RUST-BAN 190 and other Humble Protective Coatings, call your Humble salesman or contact Humble Oil & Refining Company, Houston, Texas.

HUMBLE

America's Leading ENergy COmpany



If you have a pressure system equipped with a relief valve you will want this added safety measure.

BS&B Rupture Discs act fast providing an unrestricted relief opening. Discs are available in sizes ranging from ⅛" to 44" in diameter, covering rupture pressures from 3 to 100,000 PSI.

Specially engineered discs (DV) provide relief under a wide range of operating conditions including high tolerances—high temperature — pulsating pressure or alternating pressure and vacuum situations.

BS&B Rupture Discs (Safety Heads) are likewise available in a wide combination of special materials and plastics to accommodate system requirements.

Let our engineers evaluate your pressure system and help you select the proper Safety Head or write to: BLACK, SIVALLS & BRYSON, Inc., Safety Head Division, Dept. 2-GX4 7500 East 12th Street, Kansas City 26, Mo.

BS&B

BLACK, SIVALLS & BRYSON

KANSAS CITY • EDMONTON • LONDON • PARIS • THE HAGUE

C-44

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

H_2S can be virtually eliminated from gases . . . via new Stretford process described in Publication 84. Process can be used for cleaning up synthesis gas and petrochemical feedstocks where low H_2S burdens are demanded. Can also be used to increase yields of sulfur from Klaus kilns, and can be applied to the liquid phase extraction of dissolved H_2S in distillate fractions. *W. C. Holmes & Co. Ltd.*

Circle number (64) on reply card.

Jet compressor bulletin . . . gives construction, operation, and application information. Includes a nomograph for determining the possible weight ratio of secondary gas to primary gas and a second nomograph for determining the compressor size. *Schutte and Koerting Company.*

Circle number (65) on reply card.

Magsense A-82 control relay . . . completely solid-state . . . has adjustable set point, micro-micro watt input levels of d-c current or voltage, and power up to 30 watts in the output. Offers laboratory performance under severe environmental conditions. *Daystrom Inc.*

Circle number (66) on reply card.

"New Solutions in the Science of Simulation" . . . 20-page illustrated brochure . . . details latest advances in computer technology and equipment. Included is a report on the new 5800 Dystac, a hybrid computer that synthesizes the analog computer's speed, lower cost, ease of programming, and improved output data presentation with the digital computer's unique capacity for data storage and time-sharing of components. *Computer Systems, Inc.*

Circle number (67) on reply card.

Packaged electronic control systems . . . for continuous in-line blending of two or more components . . . have potentially important HPI application for blending component stocks, TEL, and additives to form specification gasolines. Systems "remember" total amounts of each component put into the blend and control to an instantaneous total quantity ratio. *Fischer & Porter Co.*

Circle number (68) on reply card.

Swench . . . a simple, lightweight, manual impact wrench . . . requires no auxiliary equipment or power connections and allows one man, in minutes, to loosen nuts and bolts that formerly took a full crew hours to burn or sledge off. Available in eight models and six sizes to handle bolt and nut sizes from ½ to 2½ in. *Curtiss-Wright Corp.*

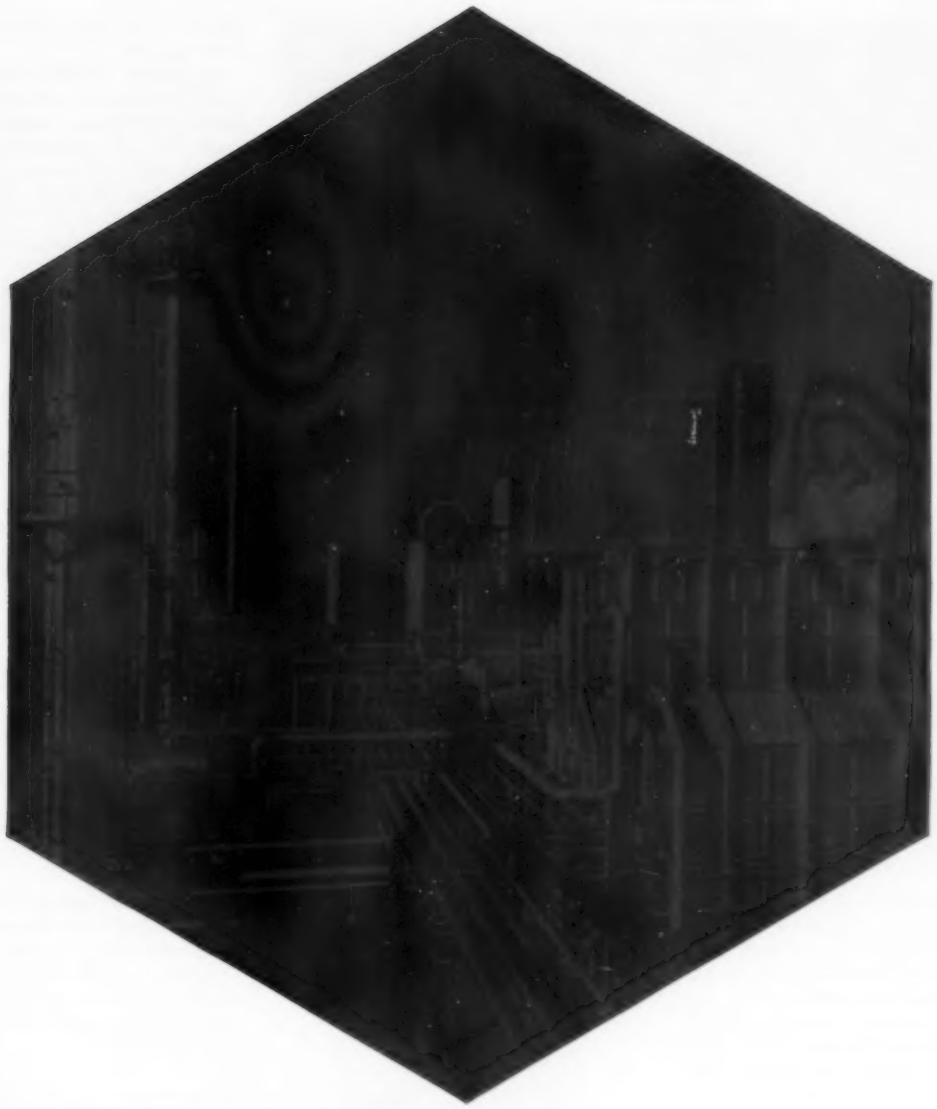
Circle number (69) on reply card.

"Real Flow-Behavior of Plastic Substances" . . . 5-page pamphlet by Dr. A. G. Epprecht, noted expert on viscous deformation of plastic substances . . . provides valuable technical data. *Drage Products, Inc.*

Circle number (70) on reply card.

Tape-to-tape converters . . . either uni- or bi-directional . . . are explained in new bulletin. Units are capable of "rearranging" information, changing the order into any desired sequence. Can change the code itself from 5-bit to 7-bit to excess 3 or any possible code as required. *Daystrom, Inc.*

Circle number (71) on reply card.



meet the demand for quality gasoline with Platforming

Marketing petroleum products in the sixties promises to be a tight competitive race for quality. Processing will be pushed more and more to produce products that are of top quality, high octane and yet are profitable to produce. Platforming, designed, engineered, and licensed by UOP, produces top quality Platformate for high energy performance.

Now is the time for refiners to evaluate their processing capabilities with the proposed future demand for the better gasoline products. Platforming enables a refiner to make a larger percentage of top quality gasoline and petrochemical intermediates . . . more profitable products.

Platforming is economical to install, reliable and easy to operate. The process utilizes a platinum containing catalyst, that is highly active and hence provides a truly continuous operation. Platforming can handle the full boiling range gasolines without prefractionation, or naphtha cuts separated from them. Any refinery naphtha feed can be processed efficiently by Platforming.

With more than a score of different processes UOP can offer you the most profitable method for either employing your existing facilities or for an entirely new operation. Let UOP engineers evaluate your processing needs now.

WHERE RESEARCH TODAY
MEANS PROGRESS TOMORROW

UOP

UNIVERSAL OIL PRODUCTS COMPANY
30 Algonquin Road, Des Plaines, Illinois, U.S.A.

FOR FURTHER INFORMATION ON
ADVERTISED PRODUCTS, SEE READER SERVICE CARD

HELPFUL WATER CONDITIONING DATA FROM BETZ

HOW TO TREAT ONCE-THROUGH

Here is a review of the water treatment problems encountered in once-through cooling water systems—and the means available for their correction.

THE TERM "COOLING WATER" is applied wherever water is circulated through equipment to absorb and carry away heat. Cooling water systems can be classified as closed, open recirculating or once-through. The once-through system, as the name implies, is one in which the water is passed through the heat exchange equipment to absorb heat and then is discharged directly to waste or is used for some other purpose. The usual source of once-through cooling water is from wells, rivers and lakes where the cost involved is that of pumping only.

In a once-through cooling system no evaporation takes place and consequently the water does not concentrate. Therefore, the water characteristics remain substantially unchanged.

Generally, the once-through cooling system is favored because of its simplicity, lower capital investment, and lower operating costs when compared to the more complex open recirculating system. This is true where water of a suitably low temperature is readily available in large volume and at a low cost—*providing the quality of the water is also satisfactory*. Too often, scale formation, iron deposits, slime accumulation and corrosion lead to inefficient operation and require frequent cleaning, high maintenance costs and equipment replacement when water of poor quality is used. As a result, operating costs far exceed those anticipated and the "simplicity" of the once-through cooling system can disappear.

Scale Formation

Calcium carbonate is usually the chief ingredient of scale formed in once-through cooling systems. It is possible to predict from the water characteristics whether a water will produce calcium carbonate deposits for the operating conditions imposed. The physical factors that primarily influence scale formation are temperature, heat transfer and velocity. The chemical factors are calcium, alkalinity, pH and dissolved solids. By calculating the saturation index and the stability index of the water it is possible to predict with a high degree of accuracy whether calcium carbonate deposits will form and produce operating difficulties.

The most common method employed to inhibit calcium carbonate scale formation in once-through cooling systems is the use of various anti-nucleating agents that possess the property of preventing crystal growth and thereby prevent scale formation. The materials most commonly employed for this purpose include the polyphosphates, tannins, lignins and polyacrylates. Specific blends of these materials make it possible to secure the added benefits of each in preventing scale formation. Treatment levels generally range between 3 and 30 ppm depending on the degree of over-saturation with respect to calcium carbonate and the severity of the operating conditions imposed.

Figure 1—Typical iron deposition in pipe line.

Iron Deposits

A special case of scale formation may be encountered in once-through cooling water systems that employ well waters containing iron. The iron content of well waters varies widely and has been noted to range between 0.3 and 30 ppm. The iron found in well waters usually exists as ferrous bicarbonate which is unstable and will undergo decomposition to form ferrous oxide at points of heat transfer.

In addition to heat, oxygen and other oxidizing agents (such as chlorine) will hasten the decomposition of ferrous bicarbonate. Iron bearing well waters commonly contain iron bacteria which utilize iron in their life cycle. Well waters containing high amounts of iron and iron bacteria will produce rapid plugging of pipelines as illustrated by Figure 1.

Efficient treatments are available that will complex the iron and prevent precipitation. While the polyphosphates are capable of complexing iron, organic complexing agents such as citrates[1] and lignosulphonates[2] are considerably more effective. Blends of these materials have been used successfully in treating industrial cooling waters containing as high as 30 ppm of iron.

When iron bacteria are present it usually is necessary to control iron bacteria by a supplementary treatment. Generally, chlorination is not used because it hastens precipitation of the iron and detracts from the efficiency of the iron retention treatments. Special organic toxicants have been developed which effectively control iron bacteria and are compatible with the iron retention treatments.

Slime Formation

Biological fouling of heat exchangers is encountered frequently in once-through cooling systems that utilize polluted surface supplies. Less frequently, well waters are encountered that contain a high bacteria count that will produce slime formation. Slime formation will seriously interfere with heat transfer and in addition will accelerate corrosion. In most instances chlorination on a continuous or intermittent basis will serve to control slime effectively. As pointed out previously, however, chlorine rarely is the best recommendation when ferrous bicarbonate is a problem.

Corrosion

Corrosion in once-through cooling systems probably is the most costly of the difficulties encountered. Replacement of expensive equipment, pipelines and the loss of production are the end result. In once-through cooling systems, the principal factors influencing corrosion are

(1) Covered by U.S. Patent 2,529,177.
(2) Covered by U.S. Patent 2,744,866.
(3) Dianodic is a Betz trade name. The methods are covered by U.S. Patents 2,711,391; 2,900,222; 2,872,281; 2,848,299.

the water characteristics, temperature, velocity, and contact of dissimilar metals. The chief variables controlling the corrosion characteristics of the water are its dissolved oxygen content and carbon dioxide concentration. Occasionally, other factors are involved such as the presence of free mineral acid or hydrogen sulfide.

Particularly where *surface supplies* are used such as rivers, streams and lakes, the major cause for corrosion is dissolved oxygen. Figure 2, shows the effect of oxygen concentrations on the corrosion of low carbon steel at different temperatures. Philadelphia tap water was used in these tests, with a pH of 6.7 and a flow rate of 2.5 feet per second. Elimination of dissolved oxygen will effectively control corrosion. Vacuum deaeration has been successfully applied to once-through cooling systems for oxygen removal, but this method entails a considerable investment cost as well as

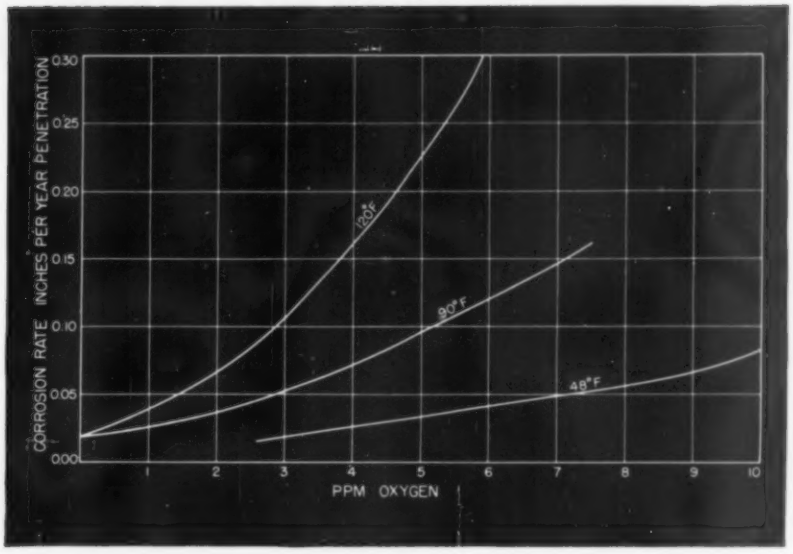


Figure 2—Effect of oxygen concentration at different temperatures.

COOLING SYSTEMS

a continued operating cost. Chemical deaeration also has been applied successfully and involves reacting the dissolved oxygen with catalyzed sodium sulfite. Chemical treatment costs with this method are approximately $1.00 per million pounds of water per part of dissolved oxygen. While waters low in dissolved oxygen can be economically treated, when the dissolved oxygen content exceeds approximately 3 ppm other chemical treatment methods usually will prove more economical.

Waters that contain appreciable amounts of oxygen can be treated more economically by inhibitors that form films or barriers which stifle the corrosion reactions. The Zinc-Dianodic methods,[3] which utilize combinations of polyphosphate, chromate and zinc inhibitors are particularly effective since they function by stifling both the anodic and cathodic corrosion reactions. The Zinc-Dianodic treatments are capable of rapidly forming a continuous, impervious film that will effectively passivate the metal surfaces and stifle the corrosion reaction. The rate at which the initial film forms is dependent upon treatment concentrations. Accordingly, the principles of pretreatment should be followed to establish the protective film rapidly. Once the film is formed, normal treatment levels, on the order of 10 to 20 ppm, will effectively maintain the film and prevent corrosion.

Well waters generally are devoid of dissolved oxygen and when carbon dioxide concentrations are low and hydrogen sulfide is absent, the corrosion rate will be negligible. However, frequently well waters do contain high concentrations of carbon dioxide on the order of 25 ppm or greater. Even in the absence of dissolved oxygen, excessive corrosion will take place not only of ferrous metals . . . but also of copper and its alloys. In these instances neutralization of the carbon dioxide either partially or totally will be required to prevent corrosion. When this corrective method is followed it is essential that the saturation and stability indices of the water be recalculated since the water may be rendered scale forming with respect to calcium carbonate and a supplemental treatment with an anti-nucleating agent may be necessary.

The most difficult of corrosion problems occurs when hydrogen sulfide is encountered. Hydrogen sulfide may be present in a water supply due to purely chemical or purely biological causes. The presence of hydrogen sulfide is more common in well waters than surface waters. Wells located in Boulder clay areas or "sour gas" fields frequently contain hydrogen sulfide. The presence of sulfate reducing bacteria may also be responsible for producing hydrogen sulfide. Generally, heavy chlorination of the water is required to consume the hydrogen sulfide. However, the proper treatment method will be contingent upon whether ferrous bicarbonate is also present, as frequently is the case.

It is essential when considering the use of a once-through cooling system that the quality of the water be investigated thoroughly from the standpoint of its potential for scale formation, iron deposits, slime accumulations and corrosion. The treatment methods for control of these problems have been well established by Betz. If you are investigating the use of a new water supply or are having problems with an existing water supply, why not call in a Betz engineer for a helpful discussion?

BETZ LABORATORIES, INC.

Gillingham & Worth Streets • Phila. 24, Pa.

■ CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

POWELL PERFORMANCE PAYS OFF

It is a matter of record, in refineries everywhere, that Powell valve performance really is paying off.

And equally important is the fact that whether you need valves to control the flow of water, oil, gas, air, steam or corrosive fluids—available in steel, bronze, iron or alloys—Powell has them.

You'll find every Powell valve is designed by engineers long experienced with the industry's valve requirements . . . and built by craftsmen who take pride making a valve you can count on.

So, by filling your flow control needs quickly, with truly reliable valves from one source of supply, you too, can be sure of valve performance that will pay off. For further information or assistance with special problems, contact your nearby Powell valve distributor or write The Wm. Powell Company, Cincinnati 22, Ohio.

ASA 300-pound Carbon Steel Lubricated Plug Valve with flanged ends. Sizes, 1" through 4", wrench operated. Screwed end valves in sizes ½" through 4" can be supplied.

175-pound W.O.G. Semi-Steel Lubricated Plug Valve with screwed ends. Sizes, 1" through 4". Wrench operated. Can also be furnished with flanged ends.

200-pound W.O.G. Semi-Steel Lubricated Plug Valve with flanged ends. Worm gear operated, sizes, 4" through 12". Spur gear operated valves, sizes 4" through 8", are also available.

115th year of manufacturing industrial valves for the free world

POWELL PETROLEUM **VALVES**

THE WM. POWELL COMPANY CINCINNATI 22, OHIO

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

S&L

CALL ON S & L FOR WELDING FITTINGS

Stocks of S & L seamless steel welding fittings are held at our works ready for despatch to all parts of the world.

Stewarts and Lloyds mine iron ore and produce the steel from which their pipes are made. They are thus able to exercise detailed quality control during all stages of manufacture from the raw material to finished product.

S & L — a name synonymous with high quality.

Specify S & L for your next project.

STEWARTS AND LLOYDS LIMITED

'O' Department,
8 Gough Square, Fleet Street,
London, E.C.4, England
Cable: Lapweld London Telex

WORKING ON OUR second million

OVER 1,000,000 **PANALARM** ANNUNCIATORS are in process industry operations

More Panalarm Annunciators are specified and used because of:

Assured Reliability due to:

- 100% Inspection for all components, both in production and final assembly.
- Complete testing of each annunciator system before shipment.

Assured Reliability due to:

- Ultrasonic cleaning.
- No in-service gassing—moisture and destructive volatile materials eliminated by high vacuum oven baking.
- Plug-ins are filled with inert gas and hermetically sealed under pressure.
- Extra safety margin for Class 1 Division 2 applications provided by electronic halogen leak detection.
- After millions of operations, max. continuous contact pressure and uniform gap spacing are assured by beryllium copper contact springs.
- Hi temp cured TEFLON-covered coils.

Panalarm maintains a large staff of annunciator engineering specialists to assist with special annunciator design and application problems. Sales and engineering offices are in all principal cities. Your inquiry will receive prompt attention.

PANELLIT DIVISION OF ISI INCORPORATED

7401 N. Hamlin Avenue, Skokie, Ill. • Phone ORchard 5-2500

Annunciators • Control Panels • Data Systems

Outstanding openings for **Fuel and Lubrication Specialists**

Lubrication Specialists: The Materials & Process Unit of Boeing's Transport Division has a number of immediate openings for lubrication specialists with a degree in Chemical Engineering, Mechanical Engineering or Organic Chemistry, plus a minimum of four years of experience in lubrication, oil refining and aircraft materials and processes or related fields. Requirements include acquaintance with general composition, properties, functioning and test procedures for a wide variety of lubricants and bearing materials. Background in thermal breakdown of hydrocarbons and synthetic oils is desirable. These positions offer opportunities to plan and conduct laboratory programs, to consult with designers on lubricant selection and to develop materials and process specifications as a member of our Structures Staff.

Fuel Specialists: In this area, Boeing has an outstanding opening for an engineer with an MS or PhD in Chemical Engineering or Organic Chemistry, plus five or more years of experience in refining, particularly alkylation, hydroforming, and upgrading. This exceptional assignment in the field of thermal stability of hydrocarbon fuels for supersonic aircraft does not require aircraft experience, but it does require a thorough knowledge of petroleum fuels, including properties relating to jet engine performance.

Send a resume of your experience, today, to Mr. Ivan G. Phillips, Boeing Airplane Company, P. O. Box 707 - 8EN, Renton, Wash.

BOEING
...environment for dynamic career growth

WEKSLER INSTRUMENTS

BI-METAL DIAL THERMOMETERS

ACCURACY:	**Within 1%**
MATERIALS:	**18-8 Stainless Steel, *welded* joints**
WORKMANSHIP:	**The finest, right through to *individual calibration***
COST:	**Being Weksler, cost is *always* moderate**

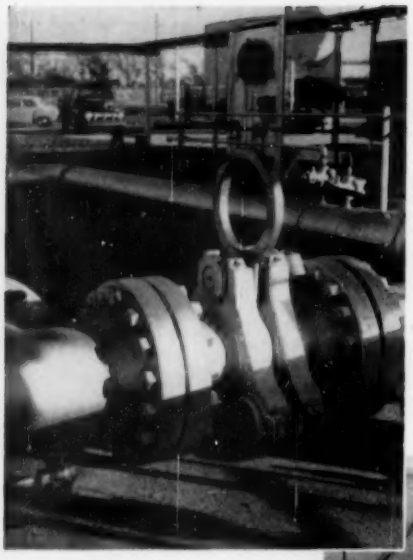
Weksler Bi-Metal Dial Thermometers are incomparable for every type of scientific temperature measurement. Dished anti-parallax dials, stem lengths to fit *all* standard thermo-wells, gasket sealed bezels, heavy crystal, *external* adjustment, and *all* standard F and C ranges are features you expect and *get* from Weksler!

WRITE FOR BULLETIN 700

WEKSLER INSTRUMENTS
"ORIGINATORS OF WORLD RENOWNED ADJUST-ANGLE THERMOMETERS"

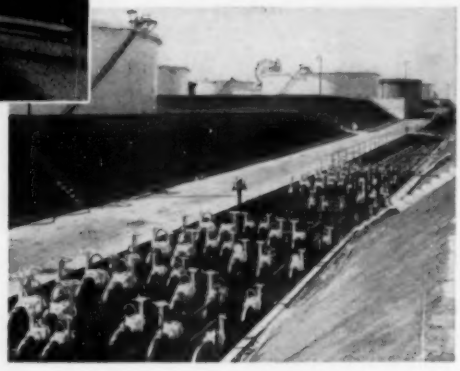
WEKSLER INSTRUMENTS CORPORATION

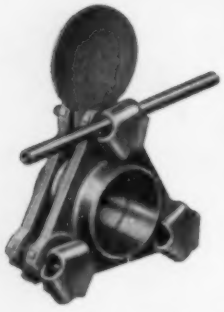
195 EAST MERRICK ROAD, FREEPORT, L. I., N. Y.
Indicating and Recording Instruments for Temperature, Pressure and Humidity



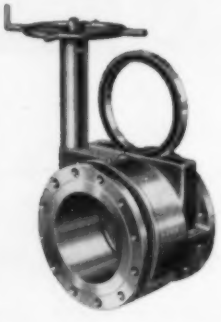
FAST, EASY, POSITIVE LINE BLINDING

Hamer Line Blind Valves





The famous 3-Bolt Hamer Line Blind Valve has set the standard for positive, dependable, economical line blinding in all industries.



Handwheel operated Hamer Rigid Type Line Blind Valves are ideal for installation where conditions prevent spreading the line to reverse the spectacle plate.

FAST . . . because one man can reverse the spectacle plate from open to closed position in a matter of minutes.

EASY . . . because bar or handwheel operation provides tremendous leverage for spreading and tightening the hubs that hold the spectacle plate. Wedges, hammers, wrenches needed for spreading conventional flanges are eliminated.

POSITIVE . . . because nothing seals as securely and permanently as the solid spectacle plate clamped between the hubs of a Hamer Line Blind Valve.

Ask your nearest Hamer Line Blind Valve specialist about the multiple advantages of installing them wherever positive line shut-off is essential. Write for new Hamer Valve Catalog 60.

WECO

WELL EQUIPMENT MFG. CORP.
HOUSTON, TEXAS

Division of CHIKSAN COMPANY *a subsidiary of* FOOD MACHINERY AND CHEMICAL CORPORATION

HV-2-60

fmc

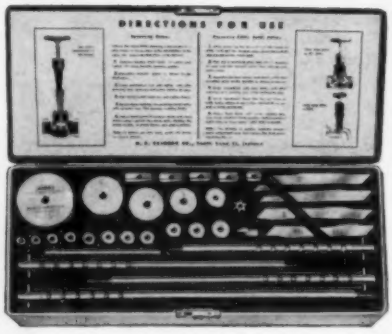
WECO UNIONS

CHIKSAN SWIVEL JOINTS

HAMER LINE BLIND VALVES

HAMER PLUG VALVES

RESEATS VALVES and BIBBS QUICKLY ECONOMICALLY



Easily pays for itself on the first two jobs!

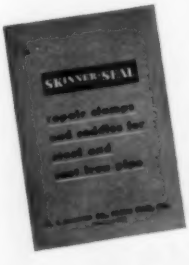
Reseats flat and tapered-seat globe or angle valves—all bibbs and faucets—in place, quickly and accurately. The saving, over tearing out and renewing leaky valves and fixtures, is tremendous.

Cutters operating under screw feed, leave worn, scored seats glass-smooth, level, absolutely accurate and tight.

A guide pilot centers each cutter; a tapered cone centers each spindle. Perfect alignment is inevitable. Cutters guaranteed. Write for literature!

2" for ¼" to 2" valves and ¼" to ¾" bibbs
List price $59.85

3" for ¼" to 3" valves and ¼" to ¾" bibbs
List price $79.50



FREE **catalog showing our pipe repair clamps, saddles, and reseating tools**

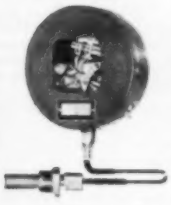
M. B. SKINNER CO.
SOUTH BEND 21, INDIANA

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

4 SERIES OF MERCOID TEMPERATURE CONTROLS

WEATHER RESISTANT

GENERAL PURPOSE



Two-Stage

EXPLOSION-PROOF

Each with these features:

External Adjustment
Sealed mercury contact
Visible calibrated dial
Visible on-off circuit
Repetitive trip point

Thirteen adjustable operating ranges from —60 +30° to 370-530°F.

Available in three case styles:
General Purpose (NEMA 1)
Weather-Proof (NEMA 1A, 2, 3, 4)
Explosion-Proof (NEMA 7, 9)

Series D-35 (10A. 115V., 5A. 230V.) Double adjustments for setting both high and low (on-off) operating points.

Series D-535 (close differential type) 5A. 115V., 2½A. 230V.) Double adjustment type for setting both high and low (on-off) operating points.

Series D-235 (very close differential type) 0.3A. 115V., 0.15A, 230V. Single adjustment for setting operating point only (minimum differential is factory set).

Series D-435 (Two-Stage Type) operates two SP-ST magnetic mercury switches at different temperatures to provide stage operation.

Write for
CATALOG NO. 860
THE MERCOID CORPORATION
4201 Belmont Ave., Chicago 41, Ill.

PETRO/CHEM news makers

▸ Naming of **Robert J. Phillips** as president heads list of recent appointments at Howe-Baker Engineers, Inc., Tyler, Texas, subsidiary of Nalco Chemical Co., Chicago.

Other appointments:

W. L. Altman, administrative assistant to the president.

H. G. Napier, chief process engineer.

R. M. Godfrey, chief mechanical engineer.

▸ **Frank H. Walk, Gerald M. Haydel & Associates** is new name of the New Orleans firm of engineering consultants and designers formerly known as Frank H. Walk & Associates.

▸ **Stewart E. Cartwright,** engineering specialist in the design and development of oil and gas process equipment, has joined Southwest Barber, Ltd., Canadian subsidiary of Southwest Industries, Inc., of Houston, as president. He will be headquartered in Calgary.

▸ **K. R. Gerhart** has been promoted to manager of manufacturing for Continental Oil's petrochemical department. Formerly assistant to the general manager of petrochemical manufacturing, he will continue to be based in Houston.

J. D. Burns, formerly assistant superintendent of the Gretna, Louisiana, petrochemical plant, is Gerhart's successor.

"SCOT" FORGED SEAMLESS RING GASKETS

MINIMUM HARDNESS

Ask for "SCOT" Gaskets at your Supply Store.

For ring Groove Flanges forged from reforging billets in the following materials in stock: Soft Iron, Copper, Aluminum, Inconel, Monel, Nickel; 1¼ Cr ½ Mo., 2¼ Cr 1 Mo., 9 Cr 1 Mo. 304, 310, 316, 321, 347, 405, 410, 430, 502, 304L, 316L, Nickel L, Kel F, Teflon.

Machined in all A.P.I.—A.S.A.

Special sizes and other type, including BX.

SOUTHERN CALIFORNIA OIL TOOL COMPANY
8220 Atlantic Boulevard
P. O. Box 30, Bell, California

Choosing an Antioxidant?

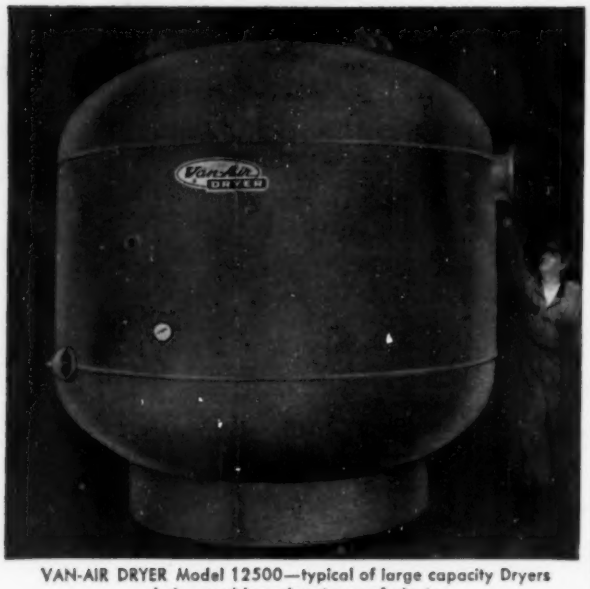
DALPAC® 4 SAVES YOU MORE

Refinery customers have found that, in comparison with other inhibitors, Dalpac 4 (Hercules 2,6-di-tert-butyl-p-cresol) saves up to three dollars on every thousand barrels of gasoline produced. Dalpac 4 inhibits gum formation, stabilizes gasoline color, and helps maintain engine cleanliness. Refiners have also found it to be excellent in turbine and transformer oils where it prevents deterioration, and does not affect electrical properties.

For additional information write:

Oxychemicals Division
Naval Stores Department
HERCULES POWDER COMPANY
900 Market Street
Wilmington 99, Delaware

N059-59



VAN-AIR DRYER Model 12500—typical of large capacity Dryers being used in various types of plants

COMPRESSED AIR DRYERS

can TRIPLE the LIFE of PNEUMATIC EQUIPMENT

By extracting water-vapor, potent acids and micronic particles from air system, VAN-AIR Dryers prevent corrosion, contamination and abrasion of pneumatic equipment. Removing these hidden by-products of air compression(not capturedinaftercooler,receiverordrain filter) adds untold hours to the life of air equipment, while it also stops air lines from freezing—even in sub-zero temperatures indoors, outdoors, in plant or yard.

Van-Air DRYER

The VAN-AIR Dryer is unique. NEVER needs regeneration. NEVER requires heat or power. NEVER causes volume loss or carry-over. Delivers air clean, sterile, non-toxic, non-corrosive and DRY (to zero° F. dewpoint). Can be installed outdoors. Operates at LOW cost of

LESS THAN 1-CENT PER 18,000 CU. FT.

PATS. PEND.

Built in wide range of thirty sizes (and multiples) the VAN-AIR can treat ANY volume of compressor output from total air for largest plant to minimal air for smallest device. There is NO LIMIT. Smaller sizes are rated for instruments, spraying, automatic machines, mobile units, brake systems, etc.

PLANT ENGINEERS — Look into the DOLLAR economy and PENNY cost of Van-conditioned compressed air. Ask for brochure on "Moisture Control."

VAN PRODUCTS CO. ★ Engineers ★ Manufacturers

5857 SWANVILLE ROAD, ERIE, PENNSYLVANIA

FLUID & GAS PRESSURE TANKS

STAINLESS & CARBON STEEL TANKS

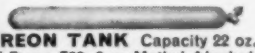
(GOVERNMENT SURPLUS BARGAINS)

Steel tanks for the handling, storage and transportation of gases, beverages, fuels, hydraulic fluids and other liquids. Stainless steel tanks for corrosive acids and gases.

J-1 PRESSURE TANK Stainless steel, surplus aircraft oxygen tank. 48" long, 24" dia. Rated for 400 P.S.I. working pressure, 18,000 cu. in. vol., 77.9 gal. capacity. ¼" pipe thread fitting at each end. New condition. Shipping weight 247 lbs. F.O.B. Chicago.
No. AJ832.....$99.50

G-1 TANK Stainless steel. Capacity 2100 cu. in. (9 gals.) 450 P.S.I. ¼" pipe thread port at each end. 24" long, 12" dia. Shipping weight 19 lbs. F.O.B. Chicago. (Two for $27.00.)
No. AJ63 Each.....$14.95

NON-SHATTERABLE CO_2 CYLINDER This type of pressure bottle was used by the Armed Forces for inflating life rafts. 18¼" long, 3¾" dia. Has ⅛" pipe thread opening at one end. Capacity 2.98 lbs. of CO_2—at 1800 P.S.I. Shipping weight 10 lbs. F.O.B. Chicago.
No. AJ303.....$2.50



FREON TANK Capacity 22 oz. of Freon F22, 6 cc Methyl Alcohol. 18¼" long, 2" dia. ⅜" pipe thread opening at one end. Equipped with brass valve. Shipping weight 3 lbs. F.O.B. Chicago. (Six for $8.00).
No. AJ834 Each.....$1.50

D-2 AIR TANK Carbon steel. Capacity 500 cu. in. (approx. 2 gals.) 450 P.S.I. ¼" pipe thread port at each end. 24" long, 6" dia. Postpaid. (Two for $8.50).
No. AJ391 Each.....$4.95

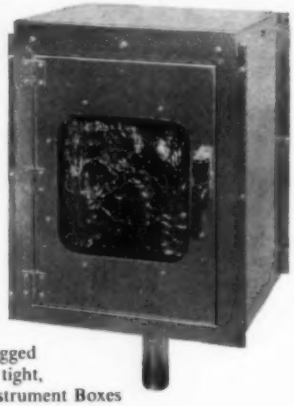
CORNELIUS HIGH PRESSURE (1500-2000 P.S.I.) AIR COMPRESSOR Three cylinder, 3-stage compressor, complete with 27 volt, D.C. 20 amp. motor, with fan. Rated 1500 P.S.I. continuous duty, 2000 P.S.I. intermittent. Pressure switch in base. As released by Air Force, in used, serviceable condition. Covered by our 30 day GUARANTEE. 11¼" long, 7" high, 9" wide. Shipping weight 12 lbs. F.O.B. Chicago. Limited quantity.
No. AJ549.....$35.00

Write today for FREE CATALOG of other EQUIPMENT BARGAINS!

GROBAN SUPPLY COMPANY

1139 SOUTH WABASH AVE., AJ-4, CHICAGO 5, ILL., WEbster 9-3793

WINSTON "Rigibilt" INSTRUMENT BOXES and METER HOUSES



Extremely rugged and weather-tight, "Rigibilt" Instrument Boxes are fabricated of 18 gauge galvanized steel with bolted, interlocking joints and zinc-coated hardware. Base plate of 3/16" steel has pipe sleeve welded to center hole for stand pipe instrument support. Furnished completely assembled. Available with insulation and steam heating coils.

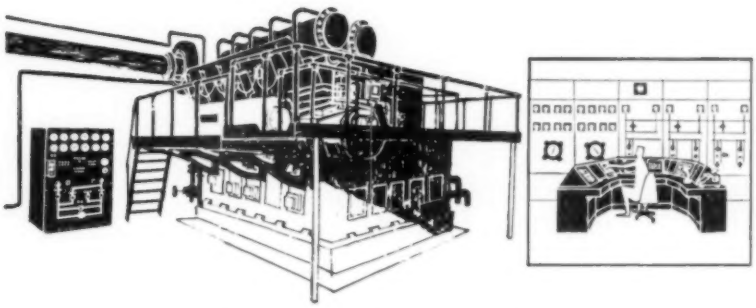
write for full details

THE WINSTON COMPANY

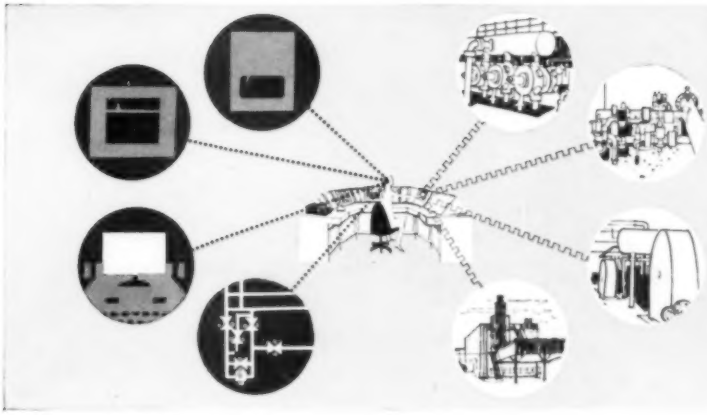
Houston, Texas • Mail Add.: P. O. Box 3056, Bellaire, Texas

North Electric Paricode® for pipe line automation

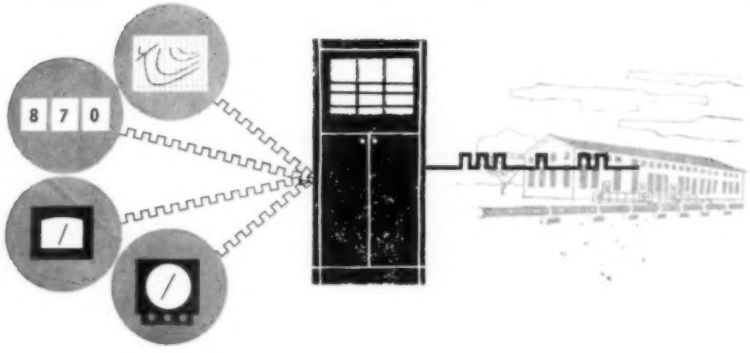
The structure of full scale pipe line automation can be divided into three major phases—North Electric brings to this field a design philosophy of progressive automation that makes it possible for companies to automate in these most logical and economical steps.



NORTH SEQUENCING UNITS provide automatic and fail-safe start-up and shut-down of all types of engines, motors and turbines with complete safeguards for emergency shut-down, fault identification and remote indication, following engine manufacturers' recommended procedures combined with operating companies' individual requirements.



NORTH SUPERVISORY CONTROL provides a centralized operator with precise control of any number of devices and operations at any of many locations, utilizing a unique 100% self-checking, fail-safe, digital coding system specifically designed to overcome the spurious noise, transient voltages and other extraneous pulses introduced into normal communications channels.



NORTH COMPUTER CONTROL makes remote stations independent of control commands or manual adjustments to maintain optimum operational status during variations of operating conditions and provides monitoring and alarms required for reliable unattended service.

North Paricode Systems bring you integrated communications, control, instrumentation and data processing from a single organization with the capability to design, engineer and produce reliable, fail-safe systems for progressive or full automation to your exact requirements.

For detailed descriptions of North Electric Paricode Systems

ELECTRONETICS DIVISION

NORTH ELECTRIC COMPANY

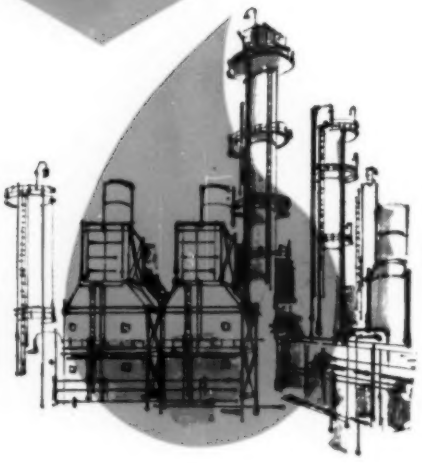
GALION, OHIO

Represented by: Lynn McGuffy Company, Inc., 304 Sklar Bldg., Shreveport, Louisiana

a molecular coat with two-sided protection

UNICOR®

protects both product and equipment



UNICOR is a potent, film-forming, oil-soluble corrosion inhibitor that plates out on metal and protects your petroleum product from contamination and your equipment from corrosion.

Whether in pipelines, refinery vessels or tanks, UNICOR provides a sure and economical means of saving dollars through assured product quality and longer equipment life. Add only 10 to 20 parts of UNICOR per million of product for lasting protection against corrosion.

With UNICOR you will eliminate contamination, get longer equipment life, reduce downtime for maintenance and cleaning, and lower power costs. For information and samples write our Products Department.

***See our PSE**

Correct selection and most effective use of corrosion inhibitors and other petroleum additives involves expert analysis and consideration of many factors. As specialists for over a quarter-century, UOP is able to provide unparalleled field service, brought to you by a member of our staff of *Product Sales Engineers. For detailed information on the UOP family of superior inhibitors and additives call or write our Products Department.

UOP®

UNIVERSAL OIL PRODUCTS COMPANY

30 Algonquin Road, Des Plaines, Illinois, U.S.A.

WHERE RESEARCH TODAY MEANS PROGRESS TOMORROW

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

HISTORY REPEATS ITSELF!

Again... TAPECOAT®
Provides the Answer For Today's Pipe-Joint Protection Problem

With the introduction of plastic-coated steel pipe, users are once again faced with the problem of providing effective protection at the joints.

This is the same situation that confronted the industry in 1941 when The Tapecoat Company originated protection in tape form for pipe joints, to match the mill coating on the pipe.

Now . . . with the advent of another method of mill-coating pipe, Tapecoat has developed Tapecoat 20 to meet all joint-coating requirements. One of the many features of Tapecoat 20 is its adaptability for coating joints on pipe protected with high-density polyethylene.

Tapecoat 20 provides a compatible bond, not only to the bare pipe, but also to the jacket on the mill-coated pipe—with no bridging of the tape from the jacket to the bare pipe.

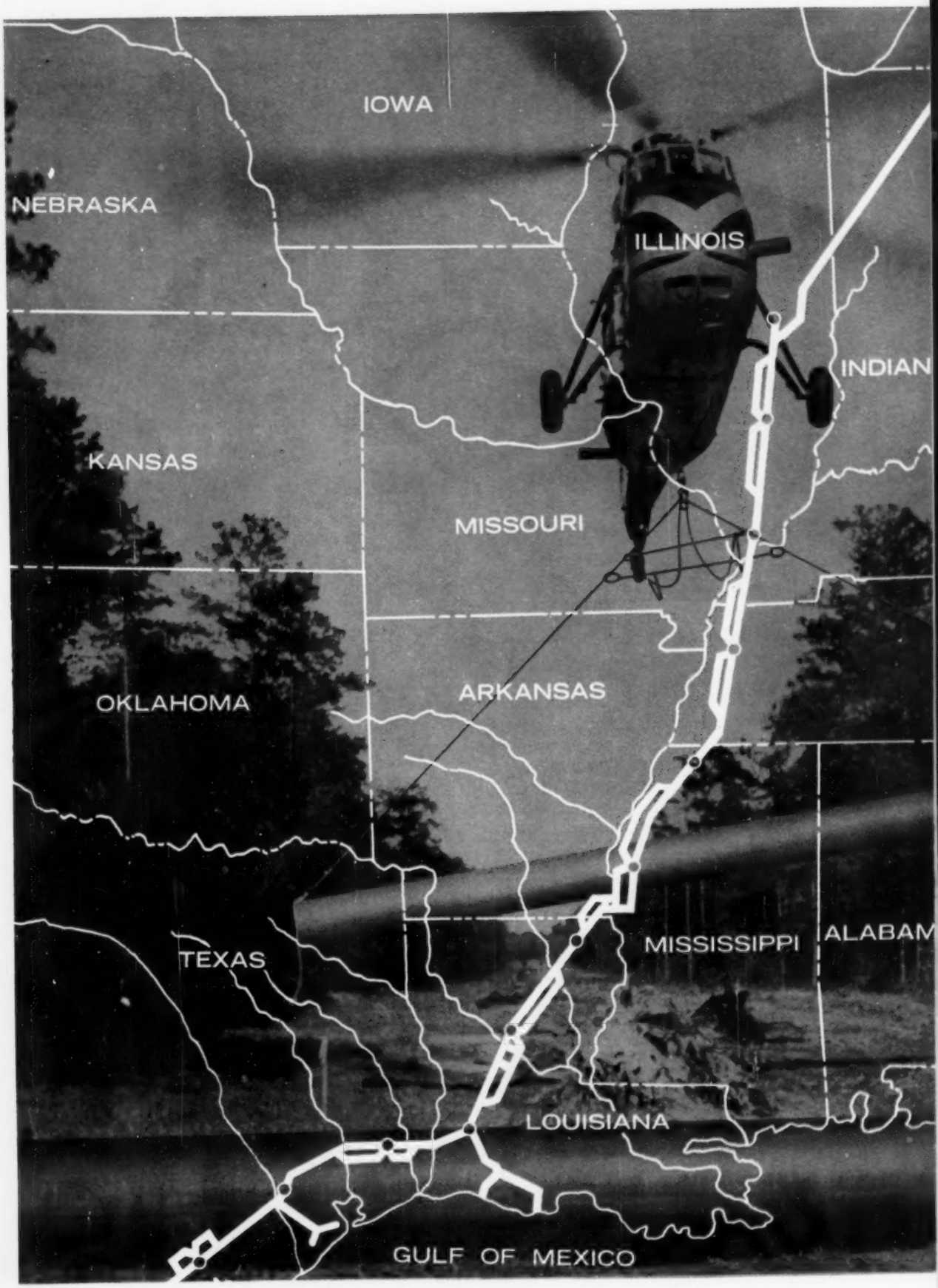
The illustrations show joints protected by Tapecoat 20. Note joint (at right) demonstrating effectiveness of bond even after Tapecoating has been pulled away from pipe surface.

Write for full details today.

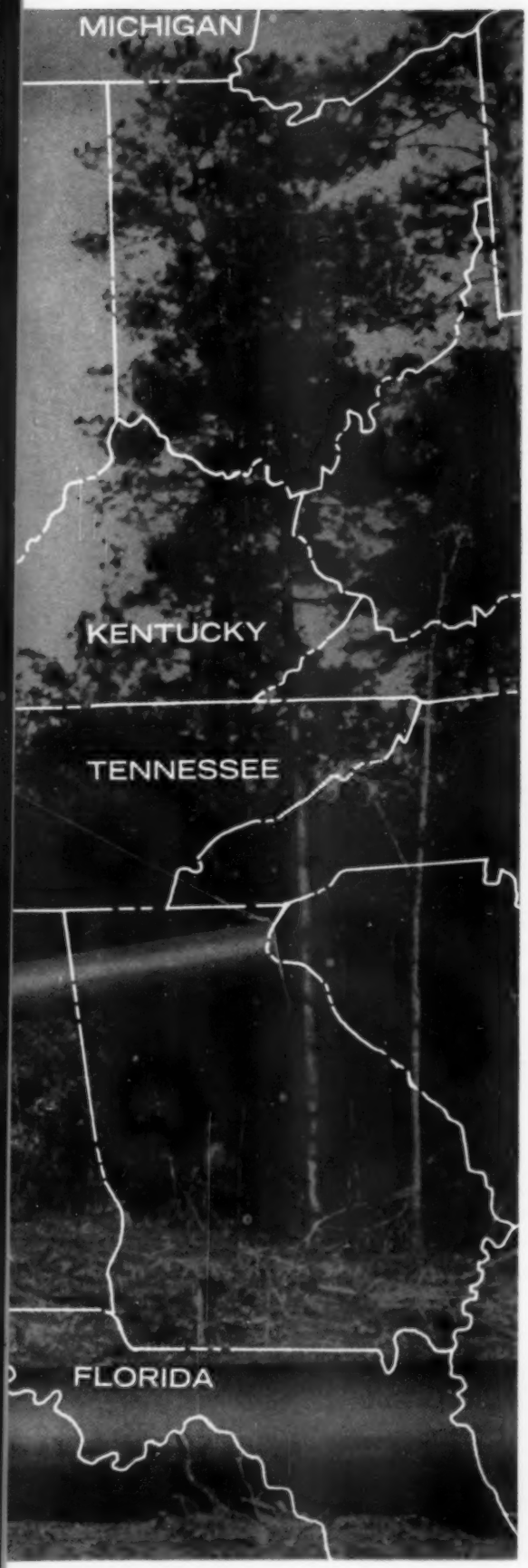
The TAPECOAT® *Company*

1567 Lyons Street ★ Evanston, Illinois
Telephone: DA 8-5220

Sales and Service Offices in New York, Pittsburgh, Charlotte, Birmingham, Houston, Lincoln, Tulsa, Minneapolis, Salt Lake City, San Francisco, Los Angeles and Seattle.



FOR FURTHER INFORMATION ON
ADVERTISED PRODUCTS, SEE READER SERVICE CARD



TRUNKLINE GAS COMPANY

strings pipe from the sky

"Pipe Lift" helps tie loops between Texas and Illinois... swells line by 135,000,000 cubic feet of natural gas per day

Linking the gas fields of Texas and Louisiana to Consumers Power Company of Michigan was the objective of Trunkline Gas Company's new pipeline project.

Besides main-line loop, the project also consisted of gathering lines in Texas and Louisiana and a main-line extension through Illinois and Indiana. Work began in August of 1959. Although progress was impeded by the steel strike, marshy terrain and a severe winter, the system was completed by June of 1960. Pipe stringing by helicopter was Trunkline's unique way of speeding up operations through some relatively inaccessible areas during the worst part of the winter weather.

A. O. SMITH supplied approximately 193 miles of 24-inch through 30-inch pipe for this important line.

FOR OVER 30 YEARS . . . A. O. Smith line pipe has always been manufactured to the highest standards of quality . . . precisely controlled at every step of production. That's why A. O. Smith pipe made and installed way back in 1928 is still in operation. That's why so much of it is found in every major pipeline project.

Through research ...a better way

A.O.Smith
CORPORATION

TUBULAR PRODUCTS DIVISION
Milwaukee 1, Wisconsin

Chicago 4 • Dallas 35 • Houston 2 • Los Angeles 17 • Midland 5, Texas • New Orleans 12 • New York 17 • Tulsa 3 • A. O. Smith INTERNATIONAL S. A., Milwaukee 1, Wisconsin, U.S.A.

Now—
Faster service from Lenkurt Electric through 6 new locations!

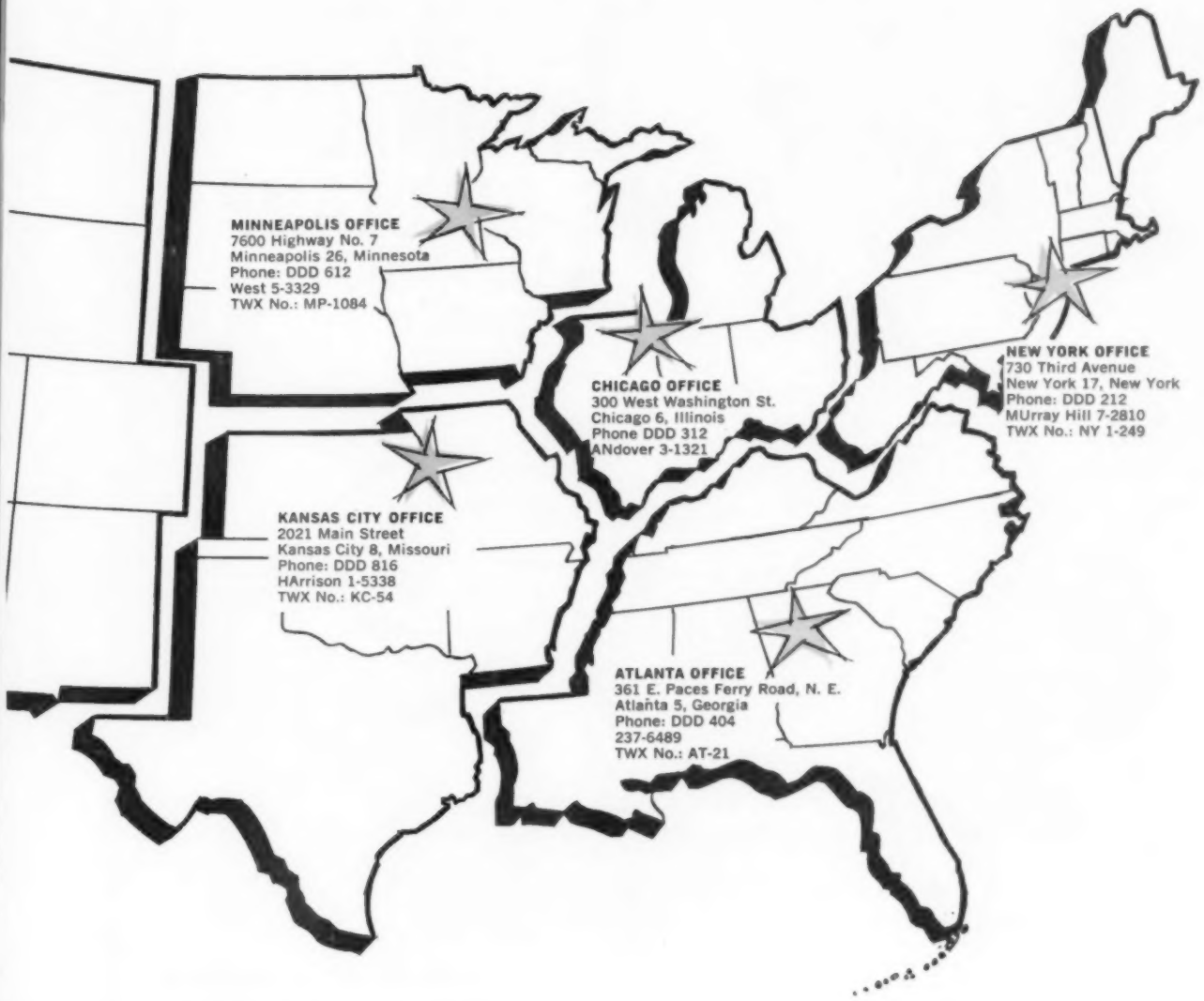
Lenkurt Electric's new telecommunication customer service is built around six regional offices, strategically located to serve you promptly and on short notice.

Each office is staffed with Lenkurt people, trained in Lenkurt traditions, and fully capable of resolving your problems on their own.

Whether you need quick delivery, fast service or engineering consultation, the Lenkurt people in your area can and will serve you with efficiency and dispatch.

Phone, wire or write—any time. Lenkurt Electric Co., Inc.,

World's leading specialists in telecommunications...



LENKURT ELECTRIC

Subsidiary of

GENERAL TELEPHONE & ELECTRONICS

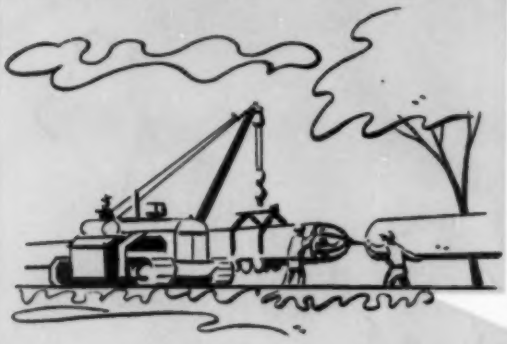
GENERAL SYSTEM

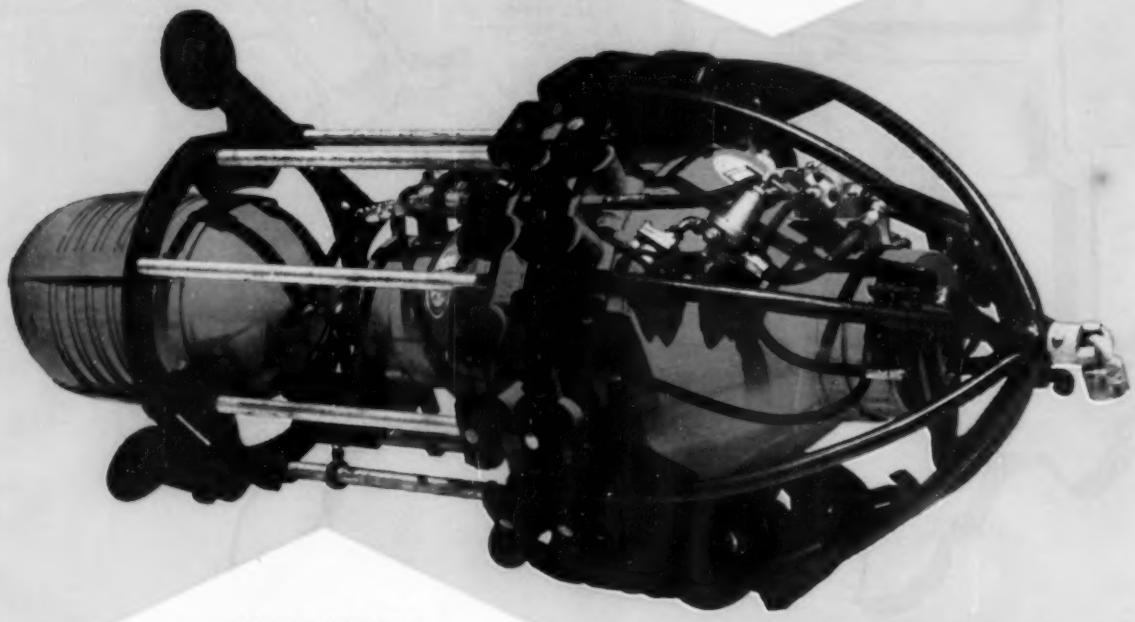
NOW CROSE-PERRAULT

PRESENTS THE FINEST, MOST POWERFUL

INTERNAL LINE-UP CLAMP

IN THE PIPELINE INDUSTRY





FEATURES:

- most powerful in the industry
- lighter weight
- faster retraction
- easier to pull through pipe
- has large diameter, ball bearing wheels for easier and faster movement of clamp
- plastic wheels furnished for internally coated pipe
- double-acting cylinders
- available with double rollers or conventional studs
- 20″ to 36″ pipe sizes
- self-propelled model available on request

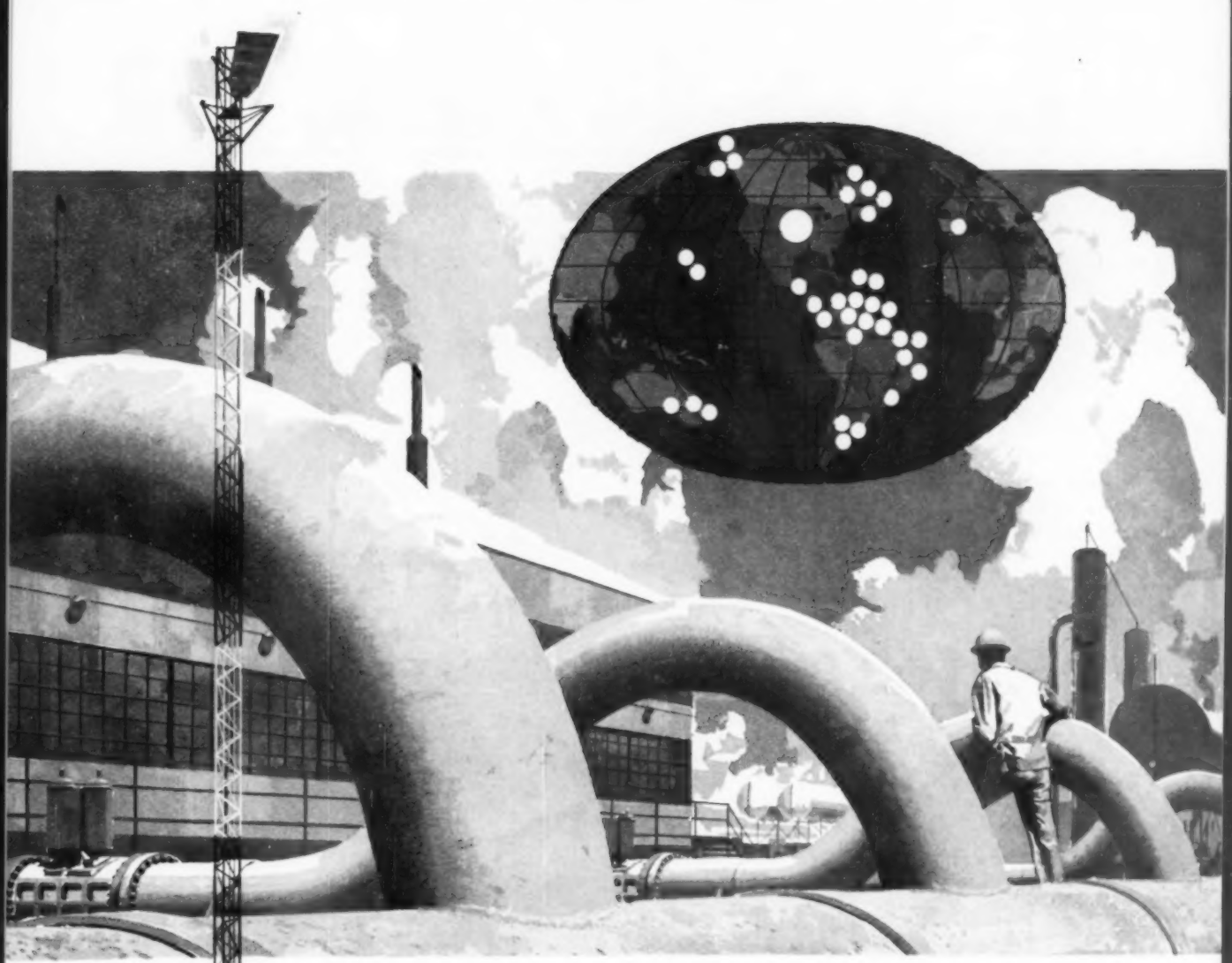
CROSE-PERRAULT LINE-UP CLAMPS HAVE LINED UP MORE MILES OF PIPE THAN ALL OTHERS COMBINED.

Crose-Perrault engineers have worked for years to keep improving the features of these clamps — now you can have the best clamp ever designed with features that mean faster and easier line-up.

Crose perrault
EQUIPMENT CORP

2765 Dawson Road • Phone WEbster 6-2171 • Tulsa, Oklahoma • BRANCH OFFICES: Houston, Texas • Elizabeth, New Jersey • IN CANADA: CROSE-PERRAULT CANADA, LTD., Edmonton, Alberta • Toronto, Ontario • EXPORT OFFICE: New York, N. Y.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



FOR PROVEN RELIABILITY UNDER ALL CONDITIONS ...CHOOSE COLLINS In pipeline communications, monitoring and control, and in many other types of installations throughout the world . . . in every extreme of climate and over every kind of terrain . . . Collins microwave-carrier systems have proved and are proving their reliability where it counts — on the job. For information on how Collins may help you solve your own particular communications problem, contact Collins Radio Company, Texas Division Sales, 1930 Hi-Line Dr., Dallas 7, Texas.

COLLINS MICROWAVE AND CARRIER

COLLINS

COLLINS RADIO COMPANY • DALLAS, TEXAS • CEDAR RAPIDS, IOWA • BURBANK, CALIFORNIA

Report on Modern Pipelining...

318 IS TODAY'S MOST ADVANCED PIPELINER

Built by the world's pioneer in mechanical ditchers, and backed by 68 years of experience in ditcher engineering, the Gar Wood-Buckeye 318 is a breakthrough for pipeliners—the most modern and most rugged tool ever designed for pipeline ditching.

The 318 is the only production ditcher equipped with a torque converter . . . the first large-capacity pipeliner compact enough to be transported on a standard low-boy . . . the first with a tail-shaft governed power train.

Efficiency is the hallmark of this continental pipeline ditcher—efficiency through Gar Wood-Buckeye's years of engineering experience in hydraulics, power conversion, and the overall design of especially reliable construction machinery.

TWO 318's BOOST PRODUCTION 30%, CUT COSTS 15% ON TEXAS PIPELINE

A Texas contractor is breaking all records for economy while ditching a 160-mile pipeline near Dumas, Texas, for the Shamrock Oil & Gas Corp.

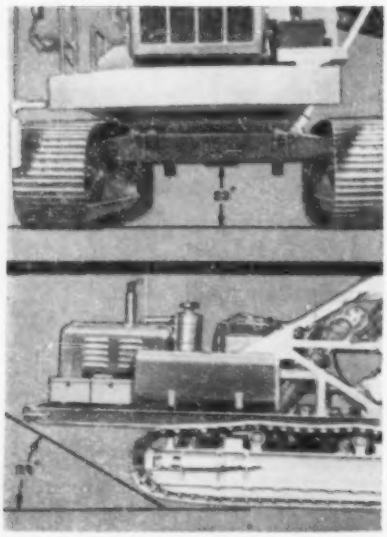
The Vaughn & Taylor Construction Co. of Odessa, using two Gar Wood-Buckeye 318's, has increased production by 30%, cut fuel costs in half, and reduced operating costs 15%.

"This is the best ditcher for pipeline work that I've ever handled in my 39 years of work," said general manager, D. D. Vaughn.

"We haven't had to touch a wrench to our machines, and already we've dug 40,000 feet of ditch and moved 32,000 cubic yards of dirt. There's no question about it—two 318's will do more work than any other three machines put together."

Vaughn reports that both the performance and operating economy of the Gar Wood-Buckeye 318 are made possible by its exclusive Torqmatic Converter Drive, matched to Gar Wood-Buckeye's modern power train and advanced hydraulic systems. These features speed up work and cut costs for pipeliners, and make the Gar Wood-Buckeye 318, the most efficient piece of equipment ever developed for pipeline ditching.

318 PIPELINER OFFERS EASIER TRANSPORT, BETTER CLEARANCE THAN ANY PIPELINE DITCHER



No other ditcher with the capacity of the Gar Wood-Buckeye 318 is so compact, so mobile. It is the only ditcher in its class that can be loaded and transported on a standard low-boy. And with the center of gravity located *ahead* of the rear crawler mounting axle, there is no dangerous weight-shift, no chance for damage as the 318 is loaded for transport.

The 318's high, 23″ clearance, with no exposed "plumbing" underneath, keeps the machine on the right-of-way, with no detours for ordinary obstructions.

Combined with this clearance, the 318's high approach angle—a full 22°—gets the machine where it has to go. Rough terrain steep banks and stream crossings are easily negotiated. And the high approach angle also facilitates trailer loading.

Whether on the job or on the road, the Gar Wood-Buckeye 318 is designed to protect *itself* from damage. No other pipeline ditcher combines such simplicity of design with so much ruggedness—one reason why the 318 is the best spearhead for *any* pipeline job, the standout in any spread.

TORQMATIC DRIVE REDUCES FUEL, MAINTENANCE COSTS

Optimum engine efficiency—the kind that saves, literally, thousands of fuel and maintenance dollars—is made possible by the Torqmatic Converter Drive of the Gar Wood-Buckeye 318.

This drive multiplies engine torque *as it is needed*, without harmful engine lugging and stalling. Because the engine works easier, maintenance and fuel costs are greatly reduced.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

GAR WOOD-BUCKEYE 318

Revolutionary Torqmatic Drive Enables 318 to Dig 1500 Feet an Hour on North Dakota Pipeline Job

A new record in pipeline ditching—1500 feet per hour, 15,000 per day—is being set in the Northwest by a Gar Wood - Buckeye 318 Pipeliner.

The job is a big one—187 miles through craggy Montana foothills, under the Missouri River, and across the prairies of North Dakota. The 8" line is being laid by Curran Construction Ltd. of Edmonton, Alberta, Canada, for the Farmers Union Central Exchange of Minneapolis, a co-op organization.

One main reason for the 318's remarkable rate, through rock, shale, and over steep grades, is its revolutionary Torqmatic Converter Drive. This drive was recently developed by Gar Wood - Buckeye to deliver the required torque, *automatically*, regardless of soil conditions. No other ditcher has it.

With Torqmatic Converter Drive, a tail shaft governor adjusts engine rpm's to maintain a constant output shaft speed as the sub-soil changes in density and weight. At the same split second, the torque converter changes torque to meet the changed work load. A fast, constant digging pace is maintained, and the operator need never change gears or adjust the throttle. Some added results: More rpm's, a resultant savings in fuel, plus much more power at the digging wheel.

The power, speed, and economy that Curran Construction is getting from its Gar Wood-Buckeye is typical of the machine's performance in any cross-country spread. And it is proof of Gar Wood-Buckeye's claim: The 318 Pipeliner gives you more production than any other pipeline ditcher.

CURRAN'S 318 TAKES 45° GRADES WITHOUT TOW TRACTOR

Ditching through the steep Montana foothills has been accomplished by a Gar Wood-Buckeye 318 without the aid of a tow tractor, according to Ditch Foreman George Roberts of Curran Construction Ltd. Roberts is supervising ditching for the 187-mile pipeline from Glendive, Montana to Minot, North Dakota.

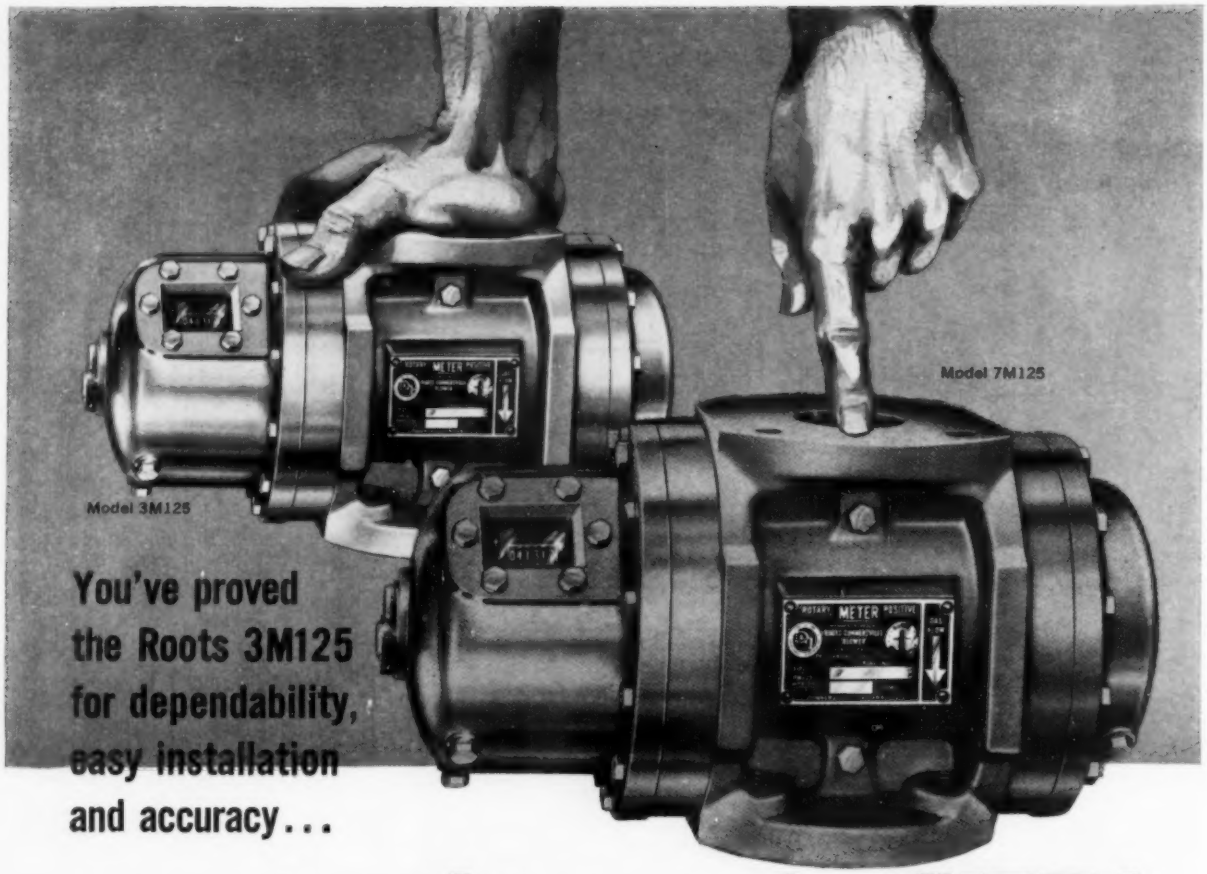
Roberts reports that grades up to 45° have been encountered, but a tow tractor has never been needed. "The Gar Wood 318 will climb as steep a grade while digging as any crawler-mounted tractor," he said.

The exclusive, specially designed power train of the Gar Wood-Buckeye 318 is the main factor behind the machine's performance on hills. Every component—engine transmission, two-speed excavator differential, "Hi-Lo" traction transmission and all drive units—are designed specifically for heavy-duty pipeline service. Unlike other ditchers, there is no "adapted" equipment in this smooth-working, high-speed power train.

GAR WOOD INDUSTRIES, INC.

Wayne, Michigan • Findlay, Ohio

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



now try this one for SIZE!

A 7000 cfh* line-mounted Rootsmeter less than 18″ long

Now you can have the advantages of both rotary-positive-displacement metering and line-mounting in a 7000 cfh Rootsmeter, Model 7M125, as well as in the already widely accepted 3000 cfh model.

Rootsmeters are accurate through wide ranges of pressure and flow—unaffected by fluctuations. And because of Roots proved operating principle, you can be sure the accuracy is permanent.

The new meters are designed for easy line-mounting. The 7000 cfh model is less than 18″ long, and the 3000 cfh model is only 14″ long. Connections are flanged to ASA C.I. standards, and line-mounting Rootsmeters require no special supports for simple horizontal or vertical installation.

There are a lot of other advantages in these Line-Mounted Gas Meters, too. You can easily read total flow through the convenient protective lens of the direct-reading volume register, yet the register itself is enclosed entirely within the meter case, eliminating problems incurred with external counters. And if you wish, the meter can be easily instrumented. Maintenance is simple: just replenish the oil occasionally; convenient bulls-eye oil-level gauges make checking easy. There are no internal valves, orifices, or diaphragms to wear or be damaged, and no stuffing boxes to maintain. Testing is easy too, with simple connections provided for standard proving procedures.

Whether your problems are in gas production, transmission, or distribution, or if you meter industrial or institutional gas, you'll find Line-Mounted Rootsmeters the most accurate and dependable, easiest to install, and most convenient gas meters you've ever used. Call your Roots-Connersville engineer or write for details of all the advantages of new Line-Mounted Rootsmeters.

*Dial Rate

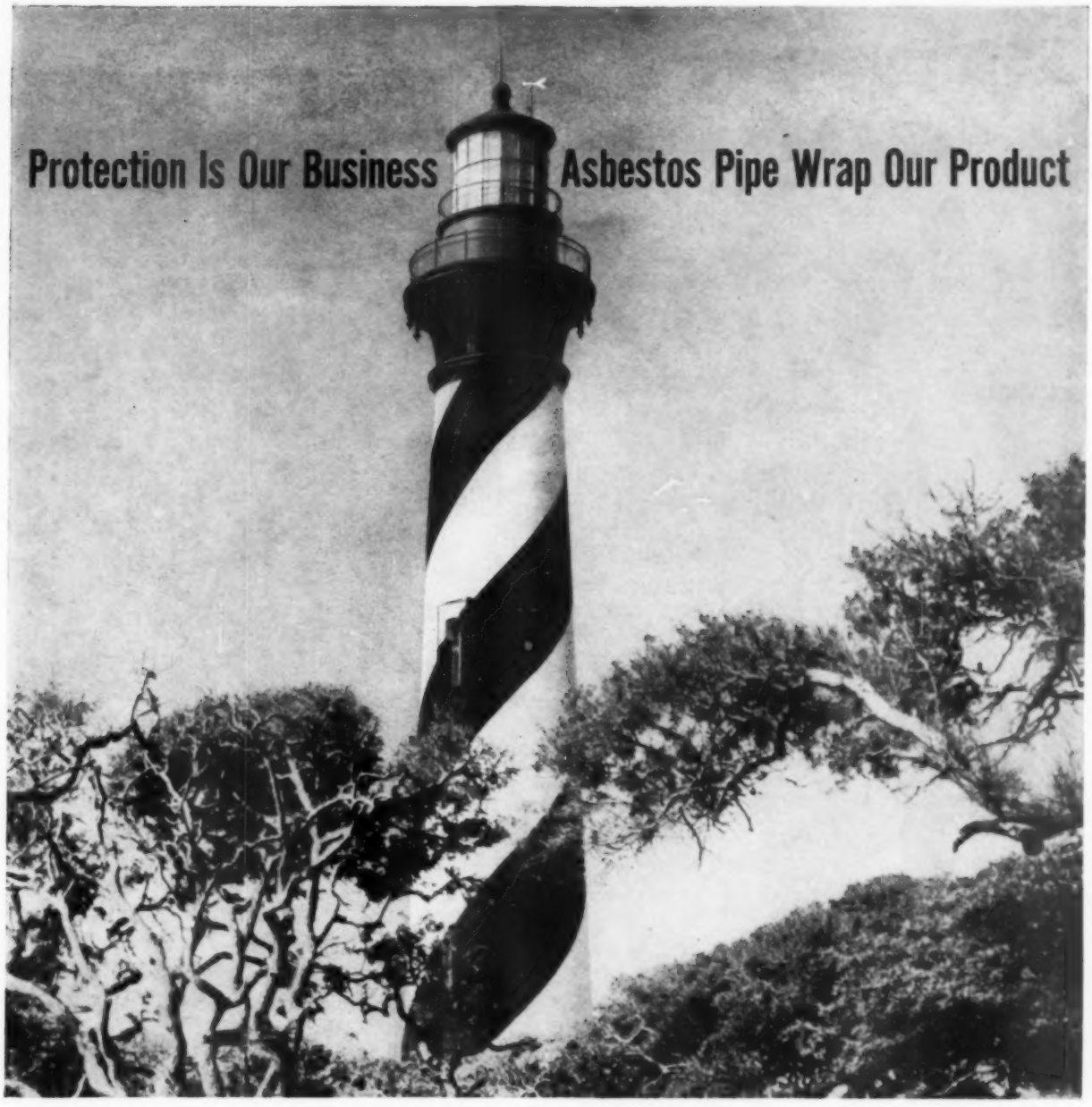
ROOTS — DRESSER INDUSTRIES INC. — OIL · GAS · CHEMICAL ELECTRONIC · INDUSTRIAL

ROOTS-CONNERSVILLE BLOWER DIVISION

900 W. MOUNT STREET, CONNERSVILLE, INDIANA

In Canada—Roots-Connersville Blower (Canada) Ltd., 629 Adelaide Street, West, Toronto

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



Through complete Quality Control—Nicolet Asbestos Pipe Line Felts have received universal acceptance for their uniformity and absolute dependability. ■ Whether your pipe line requirements demand Nicolet Asbestos #15 "Standard", #8 "Tufbestos" or #10 "Reflecto" (the new, improved, white Asbestos Felt) you are assured of getting the best protection obtainable. ■ And now—the addition of "Old Nic" Glass Wrap to this family of Pipe Wrap products makes Nicolet your best source for complete pipe line protection. ■ "Old Nic" Glass Wrap has uniform porosity which allows hot tar or asphalt enamel to bleed through, while letting hot gas escape, minimizing "holidays". "Old Nic" Glass Wrap will most effectively protect yard wrapped pipe against impact damage. It is equally effective in over-the-ditch operations. ■ **Write today for full specifications and samples of Nicolet pipe protection products.**

Distributed throughout the United States

NICOLET INDUSTRIES, INC.

FLORHAM PARK, NEW JERSEY

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

long lengths for economy

Long lengths of pipe mean fewer welds in the field . . . and fewer welds mean greater economy. It's as simple as that.

Bethlehem produces electric resistance-weld line pipe in lengths to 62 ft. Diameters range from 5⅝ in. through 16 in. OD. It's all first-rate pipe, meeting API 5L (Grades A or B) or 5LX (X42, X46, or X52) specifications.

We make ERW pipe at Sparrows Point, Md., where we also produce continuous buttweld line pipe in sizes from ½ in. through 4½ in. OD in strict conformity with API 5L specifications.

BETHLEHEM STEEL COMPANY

BETHLEHEM, PA.

BETHLEHEM STEEL

For a full line of line pipe

...thick walls

3/4 in. →

for safety

When pipe lines pass through built-up areas, safety becomes a primary consideration. The applicable codes often demand special practices, including thick-walled pipe.

That's where Bethlehem comes in. We make line pipe with ¾-in. walls from 18 in. through 42 in. OD, in 40-ft lengths. In fact, we are supplying a major gas transmission company with 36-in. OD pipe with walls measuring .844!

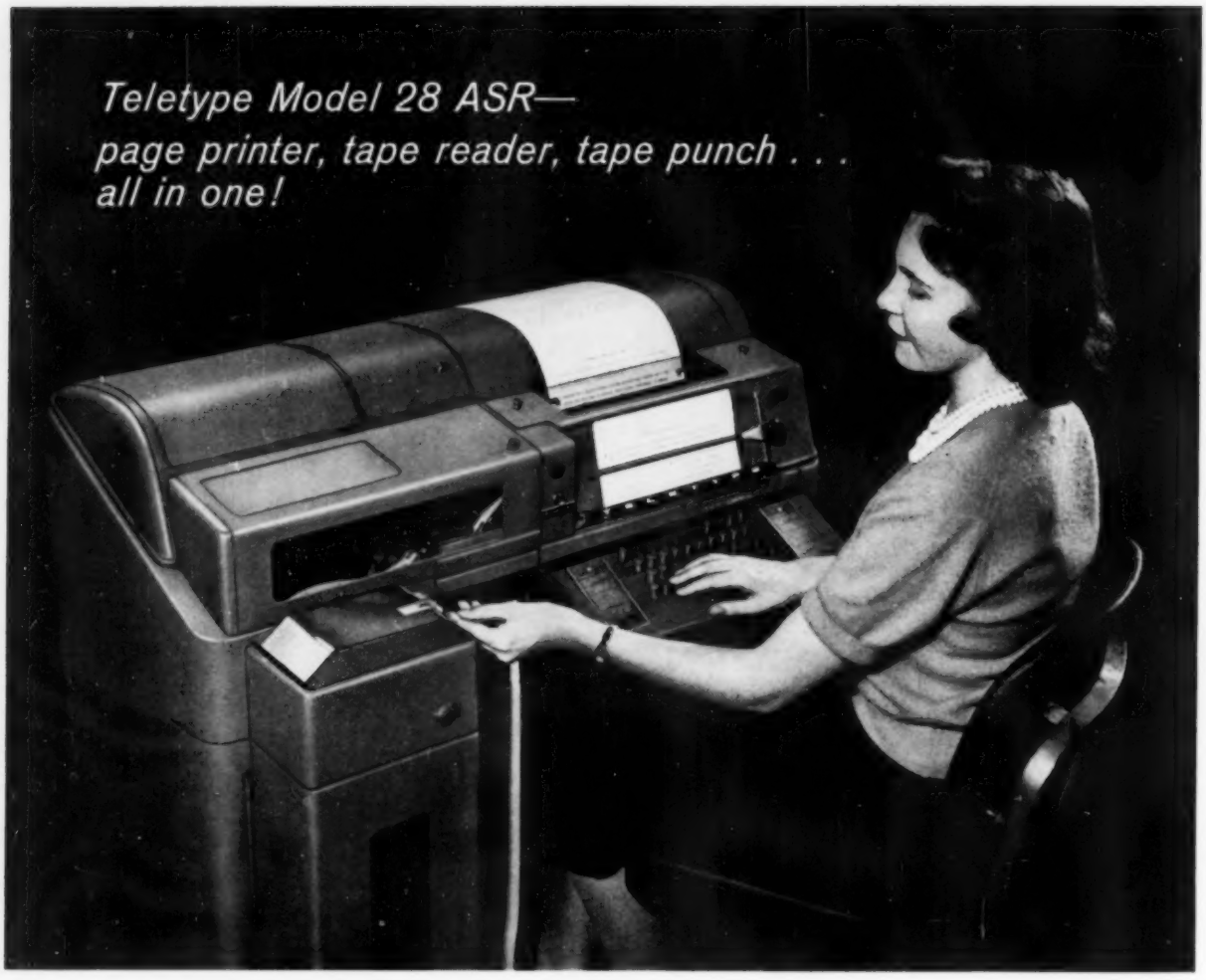
Bethlehem's large-diameter line pipe is electric fusion-welded and cold-expanded at our Steelton, Pa., mill—probably the most modern in the industry.

Steel

for Strength . . . Economy . . . Versatility

Export Sales: Bethlehem Steel Export Corporation

call BETHLEHEM STEEL



A compact data communications center

The Teletype Model 28 ASR set is a machine of many talents—time and money saving talents that are ready to go to work in your data and message communications systems.

The page printer provides facilities for sending and receiving on message paper or sprocket-fed forms. It can also be used for preparing records or as a read-out device. Platens are available to accommodate a variety of form widths, from 3⅝″ to 9″.

The punched tape equipment is unusually flexible and versatile. Facilities are provided for encoding data into tape (with or without printing on the tape) . . . transmitting from tape . . . integrating repetitive data from previously prepared tape with variable data by keyboard . . . obtaining punched tape as a by-product of communications for computer and other business machine input. There is a choice of four different punches and four different readers and, where additional tape punch facilities are needed, a model is also available with an auxiliary tape punch.

In addition, the Model 28 ASR comes equipped with a "big plus"—the Stunt Box, a built-in programming mechanism that offers an inexpensive solution to a wide variety of remote control and switching tasks, such as automatic station selection and telemetering.

All of these facilities are available to you in a compact console measuring approximately 39″ high, 36″ wide and 23″ deep.

Teletype Corporation manufactures this equipment for the Bell System and others who require the utmost reliability from their data communications facilities. Teletype equipment can be used with DataPhone and other communications services.

For a free brochure on the Model 28 ASR, write to Teletype Corporation, Dept. 47D, 5555 Touhy Avenue, Skokie, Illinois.

TELETYPE®
CORPORATION • SUBSIDIARY OF *Western Electric Company* INC.

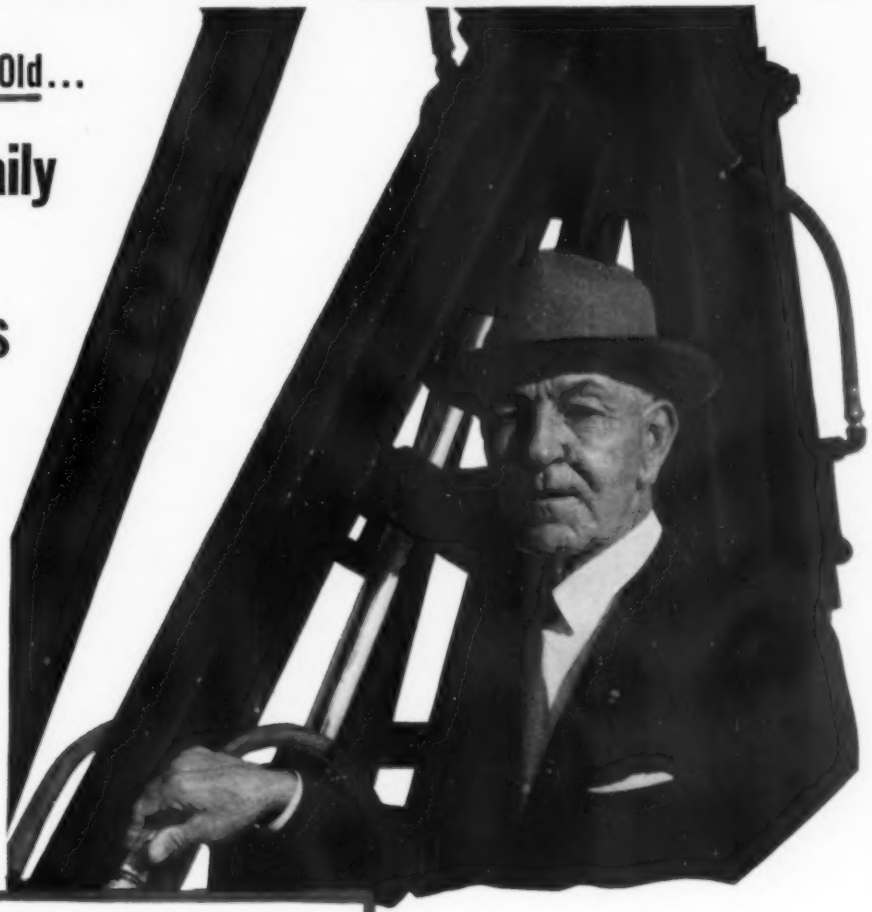
FOR FURTHER INFORMATION ON
ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Old Shermans Sell New Shermans

The Old...

"6 years of daily digging... Several years of good service left"

Mr. Robert Thompson,
General Supt.
Laurel Land Memorial Park
Dallas, Texas



And the New...

SHERMAN BOBCAT DIGGER

Compact, maneuverable 8′ or 10′ digger for light budgets, tight spots–cemeteries, inside work–or where light weight is necessary.

SHERMAN PANTHER DIGGER

Big and fast, with typical Sherman dependability... 12′ digging depth, 188° swing, exclusive filter gauge, much more for high production, low maintenance.

SHERMAN MAJOR DIGGER

Here's a perfect pair – match Sherman's durability, "dig-ability" with Fordson's rugged diesel economy. 12′ digging depth.

ALSO...

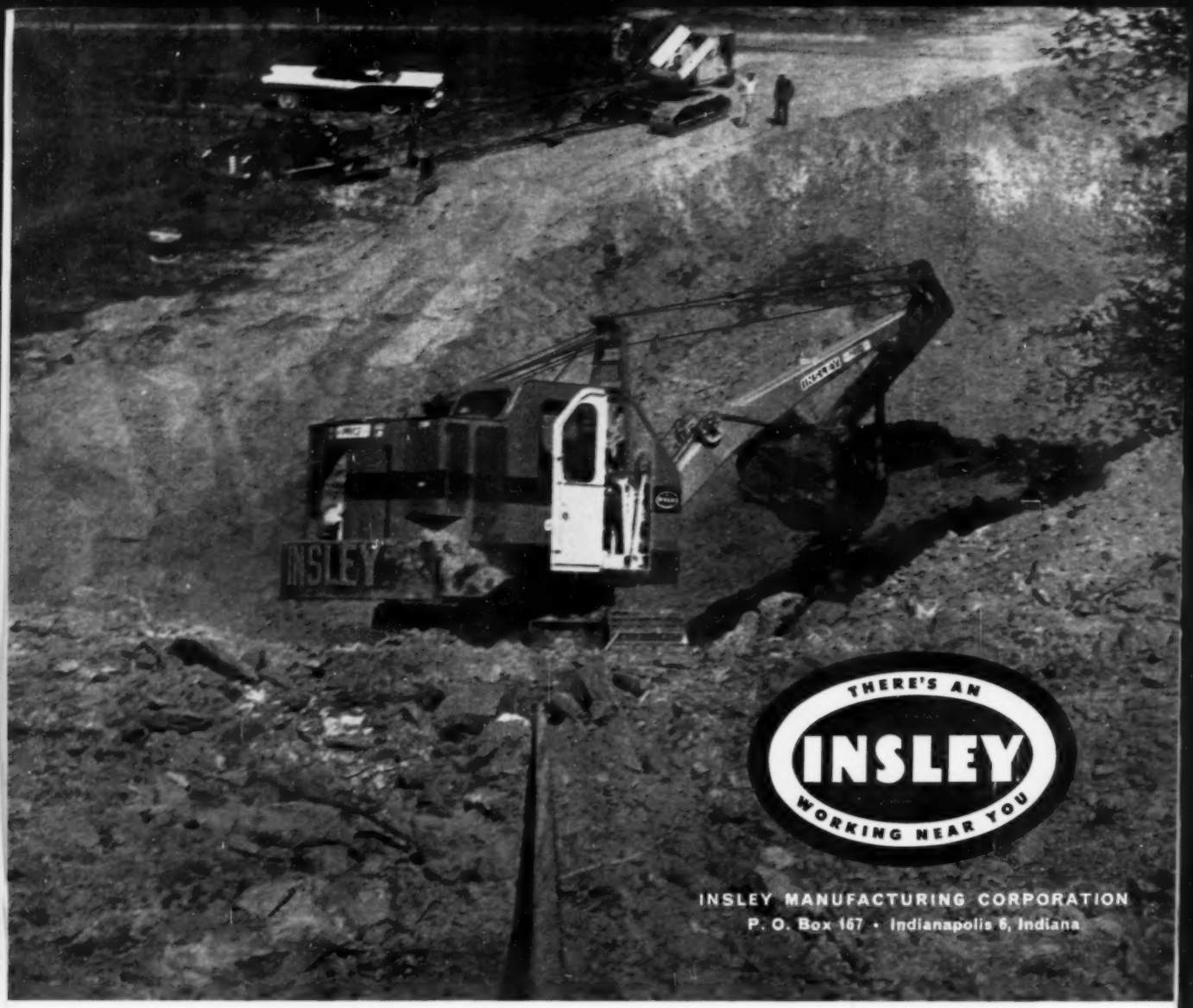
12 speeds instead of 4—For more power, more economy, equip your 4-speed Ford tractor with the Sherman combination over-under transmission to match exactly power and speed to every job. Or, for fast shuttling, install a time-saving Sherman reversing transmission.

Why not find out what Sherman can do for you? See your Ford dealer...Check the Yellow Pages or write to Allied Equipment, Ford Motor Company, 2500 East Maple Rd., Birmingham, Mich.

"We've used this Sherman almost every day for six years to dig in muck, clay, shale and rock. Maintenance and downtime costs have been small—in fact, we figure that Sherman diggers have reduced our operating costs more than 50%. Now that we're expanding, we're adding a new Sherman digger. Over the years we've decided that Sherman gives us the fast digging and consistent daily service we need for smooth operation of our business. We expect even greater productivity and dependability from our new Sherman."

SHERMAN

POWER DIGGERS
AUXILIARY TRANSMISSIONS



INSLEY MANUFACTURING CORPORATION
P. O. Box 167 • Indianapolis 6, Indiana

An INSLEY gives the best SERVICE

When the "goin' gets rough," here's the way to beat it! Call in an Insley Pipeliner. Take advantage of such "key performance" features as:

- Independent travel.
- Digging dogs in addition to steering brakes.
- Two-speed travel.
- Sealed crawler rollers and end tumblers.

But these are just a few of the Insley Pipeliner "plus" advantages. Get the full story from your Insley dealer today.

. . . gets the best service, too!

The Insley service network includes over 100 dealer locations throughout the U. S. and Canada. Each dealer has trained servicemen and is well stocked with genuine Insley parts . . . ready to handle virtually any service problem on an around-the-clock basis. Consider the importance of service and parts when you buy a new machine, and you'll buy an Insley every time.

MAXIMUM PRODUCTION

TOUGH WORK

RUGGED TERRAIN

MODERN DESIGN

PROTECTION THAT

never takes a holiday!

J-M BLUE FLAG®
Fiber Glass Wrap
for enamel reinforcement

J-M TRANSHIELD®
Asbestos Felt
for a tough outer shell

These two materials are perfect partners in pipeline protection. Here's why:

J-M BLUE FLAG is a porous fiber glass mat which gives coatings extra strength and working life. It reinforces the enamels so they are better able to resist cracking, breaking, chipping or flaking—both during installation and after the pipe is in the ground.

J-M TRANSHIELD is an asbestos felt which provides a tough, durable outer shell. Because it is made with asbestos, Transhield forms a stone-like barrier against forces attacking the pipeline. Transhield is available impregnated with either coal tar pitch or asphalt.

Johns-Manville has been in the business of pipeline protection for almost fifty years. Our research laboratory tests every new pipe wrap that comes out . . . our specially-trained J-M salesmen see these materials in service. And we can honestly assure you that we have not yet seen anything that rivals the superior protection of J-M Blue Flag and J-M Transhield. Rely on them. Specify them. For more information, write to Johns-Manville, Box 158, Dept. PE-461, New York 16, N. Y. In Canada, address Port Credit, Ont. Offices throughout the world. Cable: Johnmanvil.

JOHNS-MANVILLE JM PRODUCTS

SATELLITE STATIONS . . . AUTOMATION SOLVE CAPACITY PROBLEM FOR SERVICE

V. L. RUPE, *Mechanical Engineer*
Service Pipe Line Company

WHEN FACED with a forecast deficiency on its Wyoming to Missouri system, Service Pipe Line added horsepower at existing stations and constructed new satellites. This is a description of the facilities that permit attendants at two stations to control all six mainline stations on this 625-mile system.

The Initial System

Service Pipe Line laid its 20-22-24-in. crude line in 1954 to replace an old 12-16-in. system between Ft. Laramie, Wyoming, and Freeman, Missouri. The new line provided a more accessible outlet for crude oil from Wyoming, northeast Colorado, southwest Nebraska, and northwest Kansas.

Upon completion of new stations at Ft. Laramie, Wyoming, Sterling, Colorado, and Laton, Kansas, the new system's capacity was 180,000 bbl per day average into Freeman.

Ft. Laramie and Sterling were completed as three-unit electrical-centrifugal stations. The new station at Laton had two high-speed engines driving centrifugal pumps. In addition, three stations were built to inject into the line—two between Ft. Laramie and Sterling and one between Laton and Freeman.

The stations were initially designed for attended operation, although Sterling was attended on a part-time basis. The three injection stations were operated by field gagers. Ft. Laramie pumped to Laton with a relay at Sterling, and Laton pumped to Freeman, the terminus of this line.

The Present System

Pumpings through this system increased until forecasts showed a capacity deficiency would exist by 1959. Service immediately proceeded with plans for additional relay stations and machinery increases at existing stations. With these facilities in operation by the end of 1959, average annual capacity became 223,000 bbl per day into Freeman.

The units at Ft. Laramie were changed to increase station horsepower. A single unit electric-centrifugal station was built at La Grange, Wyoming, between Ft. Laramie and Sterling. Herndon station, with two engine-driven centrifugal units, was constructed between Sterling and Laton. A third engine-driven unit was added at Laton. Scranton, with a single electric-centrifugal unit, went in between Laton and Freeman.

Ft. Laramie and Laton continue to operate as attended stations. La Grange and Scranton operate as unattended relays. Sterling and Herndon are partially attended relay stations with actual operation remotely controlled. Ft. Laramie monitors and controls La Grange, Sterling, Herndon, and the injection station at Enders, located between La Grange and Sterling. Laton monitors and controls Scranton.

Common Design Features of Electric Stations

General. The electric stations are classed as "outdoor," with the metal-clad switchgear, machinery, and manifolds unhoused. A building houses auxiliary equipment, sequencing cabinets, control and telemetering equipment, and serves as an office at the attended stations.

Machinery. The horizontal, steel-case, centrifugal pumps are driven through a floating shaft by 3600-rpm, 2300-v, weather-protected, induction motors. The design features pump coupling hubs mounted by the "S.K.F. Hydraulic Pressure System" for ease of servicing inboard pump bearings and seals. Most pumps are equipped with double-seals and with a pressure shutdown system for seal failure. Pumps and motors are bolted directly to sole-plates grouted in the foundation. This feature, together with a standard centerline-to-base dimension, simplifies machinery interchangeability.

Station Piping. All piping at unattended stations is buried. Gate valves in piping other than the mainline are of the venturi pattern and motor-operated. Scrapers are run through the resilient seated "divider" check in the mainline at stations where there are no traps. A vertical strainer, installed in the station suction line, protects the pump. Orifice flanges at the relay stations are installed on the station suction side.

Scraper Detection. Service has developed its own scraper detector, which is installed through a standard tapping nipple. The incoming detector is installed several hundred feet upstream of the station's suction connection to allow sufficient time for the isolation gate to close while the scraper travels between the detector and the station. The outgoing detector is immediately downstream of the station discharge connection. The station shuts down automatically when the scraper trips the incoming detector, and requires a supervisory restart command.

A single 18-in. to 24-in. combination scraper makes the 625-mile run from Ft. Laramie to Freeman, although it is removed and re-launched at Sterling and Laton.

Local Control and Protection. In general, control instrumentation is electronic. Instruments are of the miniature, graphic-panel type, mounted in the sequencing cabinet at the unattended stations, and on a graphic control panel at the attended stations. Station case pressure and flow-rate

FT. LARAMIE STATION. Main pumping units are in foreground near office building. Three units on left are each 1250-hp and pump Ft. Laramie-Freeman system. Unit on right is 400-hp positive displacement pump for pumping to Medicine Bow on Service's Utah system. Two of the tank suction boosters are at extreme right. Station discharge on left is Ft. Laramie-Freeman system. Each crossover in manifold serves an individual tank.

are recorded only. Station suction and discharge pressure are both recorded and controlled. Pressure and flow transmitters, together with protective line-pressure switches, are mounted at the line.

Instrument air is required for the pneumatically-operated discharge control valve. The use of outside air supply tanks plus automatic water knocks-outs in compressor discharge lines generally solves the freeze-up problem.

Service has developed an automatic programmer to open slowly the pneumatic throttle valve. This minimizes rapid line-pressure change and the possibility of motor overload.

The basic control scheme is identical at all stations, with the throttle valve positioned to maintain safe suction and discharge pressures. The system is automatically selective, with the lowest controller output in command of the air-to-open valve.

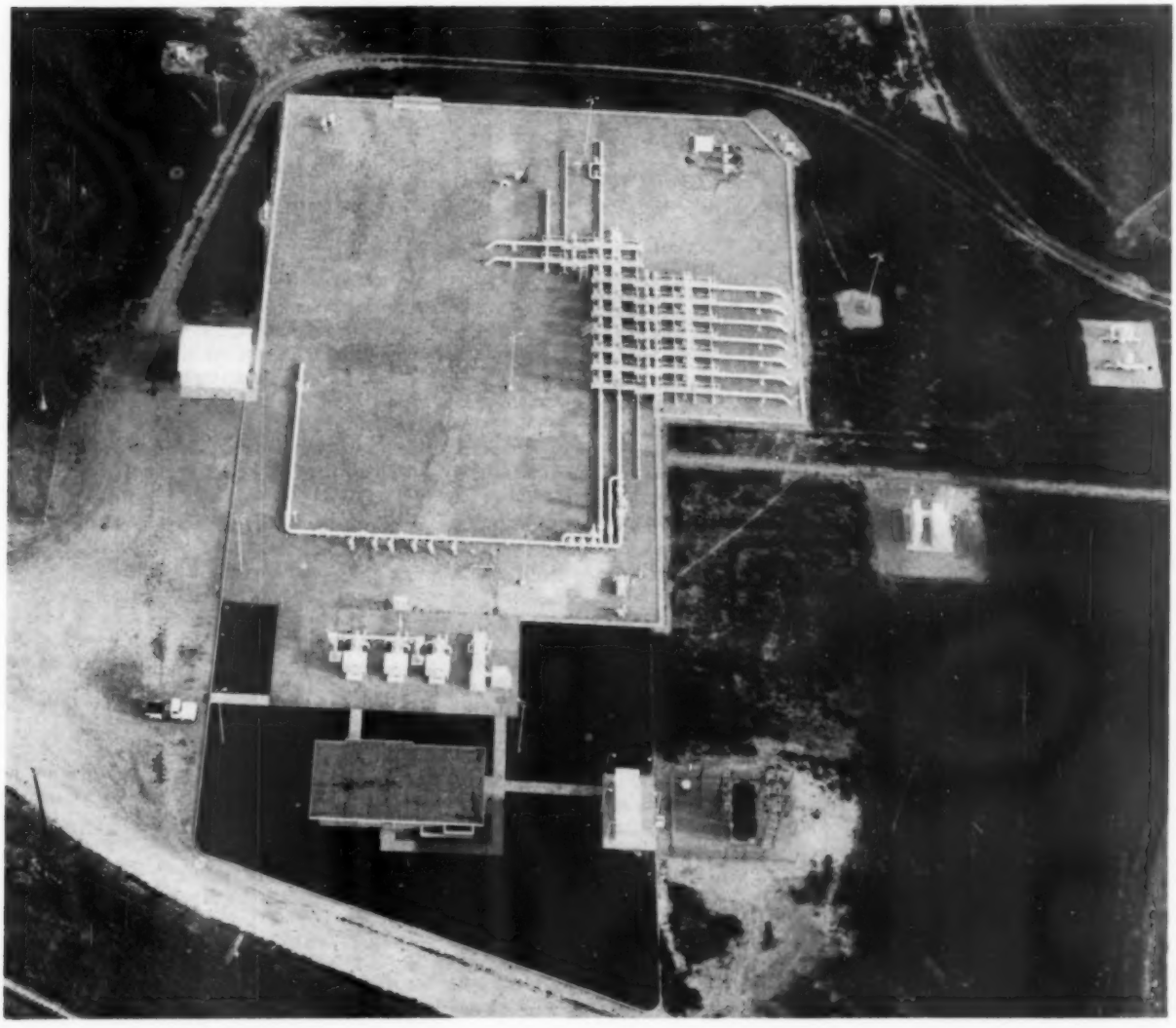
Equipment operation is sequenced automatically for unit start or stop. With the unit shutdown, suction and discharge valves are closed. A pushbutton action starts the suction valve. As this valve opens, limit switches in its operator start the discharge valve and cause the shift of a solenoid valve in the programmer to vent the throttle valve diaphragm-case. As the discharge valve starts to open, limit switches in its operator initiate the start of the motor. As the motor starts, the solenoid valve in the programmer shifts to close the venting of the throttle valve diaphragm-case, and the controlled air signal is connected to open slowly the valve. Once the air system between the programmer solenoid valve and station control valve is filled, the throttle valve responds normally to control-signal changes. Suction and discharge valves close simultaneously and the motor is de-energized upon a shutdown signal.

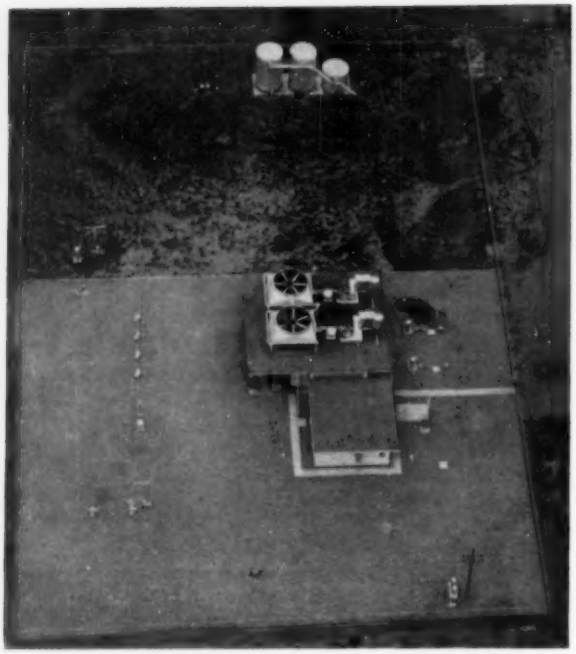
Local instrumentation provides the usual machinery and line protection. Each fault is located by checking annunciator panel drops.

Common Design Features Engine-Driven Stations

General. Many features of the engine-driven stations at Laton and Herndon are the same, although Laton is attended and Herndon is designed for unattended operation.

Machinery and Machinery Auxiliaries. The dual-fuel engines are 4-cycle, 16-cylinder, 9-in. by 10½-in. "V" type, turbocharged, and rated at 2083 hp at 1000 rpm. Each engine drives a 10-in. by 14-in. by 16-in. horizontal, steel-case, single-stage, centrifugal pump through a 3.964 to 1 single-step gear. The engine is connected to the low-speed gear shaft by an "inflated-tire" type flexible coupling. The pump is connected to the high-speed gear shaft by a floating shaft and flexible couplings. The unit is installed on a common foundation with the engine and gear bolted to a grouted skid, and the pump bolted to a grouted sole-plate.





HERNDON STATION. (Top of photo is south). Incoming headgate is in enclosure at bottom center of fenced area. Station suction and discharge isolation valves are at lower left. Line of valves parallel to and at left of station building are unit suction and discharge valves. Fuel gas regulators, flow meters, and surge tanks are on right of engine room. Installations on roof, from right to left, are: Intake air filters, intake air humidifiers, exhaust stacks, exhaust mainfold vents, engine room exhaust fan, cooling water heat exchangers. Pumps are under canopy to left of engine room.

The building wall serves as the "fire-wall" between the pump and gear.

Many features lend the engine to remotely controlled operation including air-motor starting, automatic shift to and from dual fuel, pneumatically controlled fuel rack drives, and engine-driven service pumps. The engines respond readily to dictated speed changes.

Each engine has its individual set of auxiliary equipment. The principal difference in auxiliaries at Laton and Herndon lies in the radiator fan drive. At Laton, the 14-ft, 6-blade, horizontal fan is driven by a two-speed electric motor. The fan at Herndon has a hydraulic drive, with the engine supplying power to the hydraulic pump.

The arrangement of auxiliaries is unique in that the radiators, air filters, and air humidifiers are installed on the engine room roof. Water piping is arranged to facilitate rapid drainup to the hot-well located below the engine room floor. Intake-air and exhaust piping extend directly upward from the engine through the building roof. All other service piping is in covered, engine-room trenches, with the exception of the water lines to and from the radiator. The make-up water pump is mounted in the hot-well. The electric-motor-driven auxiliary lube oil pump is installed in the conduit at the free end of the engine. The lube oil cooler is in the conduit below the floor line, and the lube oil filter is at the free end of the engine with only its cover above floor line.

Station Auxiliaries. Two electric-motor driven air compressors supply engine starting and instrument air. Compressors are fully automatic in operation. Laton's engine-driven auxiliary generator is rated at 125 kw and Herndon's at 75 kw. Both stations normally operate on a commercial power supply for auxiliary equipment. Auxiliary generator units are automated to start and take load upon loss of the normal power supply, and to shutdown upon its restoration.

Station Piping. Both Herndon and Laton are multi-unit stations and the main line pumps are manifolded to operate in series. Main line and pump suction and discharge valves are motorized.

Engine Fuel and Lube Supply. The engines burn straight diesel oil, or natural gas with diesel oil, as pilot fuel. Fuel oil is trucked in and stored in two 400-bbl tanks at each station. The fuel oil gravitates to the engine-driven fuel booster. Excess overflow and drain gravitate to a buried fuel sump that is evacuated by an automatically-operated pump discharging back to storage.

The fuel gas supply enters a central header in front of the engine room. Each engine has its complete fuel gas system including surge tank, pressure regulators, automatic shutoff and vent valves, and flow-meter.

Lube oil is delivered by tank truck and gravitates to the engine from a 200-bbl storage tank. Crankcase level is automatically maintained by a level control valve. Lube oil drainage can be pumped to storage to be burned as fuel.

Local Control and Protection. Most operations are monitored and controlled by pneumatic instrumentation. Line-pressure transmitters are mounted in a cabinet on the pump slab. Transmitters furnishing engine operating intelligence are mounted in a cabinet at each unit. Flow transmitters are mounted at the line.

All station operations can be monitored and controlled at the graphic panel in the office. In addition, engines can be started and shutdown at the unit, with control from the office locked out. The general scheme of sequenced operations that control the units is covered in the description of Herndon's special features.

Pumping is controlled by varying engine speed, either manually or automatically. This is done by regulating the air pressure signal to the rack-drive mechanism — either a diaphragm motor or a pneumatic-hydraulic governor. The automatic control system is selective, with the lowest of the output signals from the suction pressure, discharge pressure, or flow controller in command. In addition, both Herndon engines and Laton's No. 3 engine have rpm controllers. Each unit has manual-automatic switches for manual speed regulation.

The usual pipeline and machinery operating conditions are monitored. Other data shown by panel instruments include:

Recorded

- Fuel gas flow rate
- Engine lube oil pressure, in and out
- Engine cooling water temperature, in and out
- Engine exhaust temperature

Indicated

- Station electric auxiliary supply voltage
- Engine fuel gas pressure
- Engine rpm
- After-cooler air temperature, in and out
- Fuel-oil filter pressure, in and out
- Engine lube oil temperature, in and out
- Engine lube oil level (% full)
- Turbocharger lube oil pressure
- Engine total hours operated
- Gear oil temperature
- Gear oil pressure

In addition to the usual pump and line protection, local instrumentation shuts down the unit in the event of the following faults:

High gear lube oil temperature
Low gear lube oil pressure
High gear bearing temperature
Low engine lube oil pressure
High engine exhaust temperature
High engine lube oil temperature
High engine water temperature
Low instrument air pressure
Engine overspeed
High station sump

Each fault is indicated by means of a light on the control panel.

Individual Station Features

Ft. Laramie

Ft. Laramie is an open station receiving crude from Service's Wyoming system, plus custody-transfers from foreign pipeline companies. The bulk of these receipts is batched to Laton.

The station has 10 tanks. Nine of these tanks are served by single tank lines with 125-hp, "in-line" type, suction-booster pumps. To facilitate bi-directional flow through the single tank line, a three-port, two-way check valve is installed on the pump discharge with a bypass line around the pump. Electric tank gages, with the receiver located in the station office, monitor tank level.

Manifolds are above grade and frequently operated valves are motorized. Valves selected for their "double-block" features are used on incoming foreign lines, and their position is remotely indicated.

Remotely read gravitometers monitor both the incoming stream from Service's Casper station and Ft. Laramie's discharge. Automatic samplers are installed on the incoming foreign lines.

In addition to tank boosters, auxiliary pumping equipment includes the 125-hp station suction booster and the 40-hp suction sump.

The station is of the "outdoor" type, previously described. Three 1250-hp electric-motor driven, 10-in. by 12-in. by 13-in. two-stage centrifugal pumps manifolded for series operation have a capacity of 6500 bbl per hr at a discharge pressure of 1170 psi (line-limit) pumping the Ft. Laramie-Laton stream.

A single operator on tour supervises and monitors local operation from a control panel in the office building. This operator also monitors and controls La Grange, Enders, Sterling, and Herndon.

La Grange

La Grange exemplifies the typical, unattended, electric-centrifugal relay station previously described. There is a single 2000-hp driven, 10-in. by 12-in. by 14-in. two-stage centrifugal unit. The station is designed to accommodate a second unit. Although the design permits local operation as required, Ft. Laramie generally supervises and monitors La Grange.

Enders

This station injects Nebraska crude into the stream from Ft. Laramie. The two main units are 200-hp electric-motor driven, 4-in. to 7¼-in. by 10-in. duplex power-piston pumps. Auxiliary pumps include a 30-hp suction booster and a 25-hp unit to service trucked-oil facilities.

Enders has two tanks totalling 65,000 bbl capacity. The largest of these is equipped with level switches and is normally used in the station's automatic operation. Enders also has two 1000-bbl tanks for the trucked oil receipts.

Enders can be controlled automatically, remotely, or manually. Since the station can inject only in selected passing grades, a gravitometer signal is used to start the pumps under automatic control. The units automatically

SCRANTON STATION. (Top of photo is East). Station suction gate is shown at bottom left. Pumping unit is 2500 hp. Gage and transmitter cabinet is shown in approximate center of unit and valve area west of the control valve (in enclosure). Station discharge valve is in large enclosure northeast of control valve. Manually operated station discharge headgate is just below fence in upper left of photo. Control building is top center. Note weather protected switchgear and substation.

shutdown on low tank level or a gravity change in the passing stream. Ft. Laramie receives telemetered operating data from Enders and can over-ride the gravitometer's control to start and stop the station. The station's suction booster is automatically started and stopped by suction pressure at the main pumps when these units are operating.

Sterling

This is an outdoor, electric station designed to be remotely controlled from Ft. Laramie, although it is attended on a part-time basis. Sterling operates essentially as a closed relay station, with the Colorado crude receipts injected into the incoming stream on the station's suction side.

Sterling has four tanks. One of these is a 130,000-bbl tank used principally to receive a metered foreign delivery. The other tanks receive trucked oil. Use of meters permits the 130,000-bbl tank to be utilized as a working tank, offering greater operating flexibility with regard to injection.

Sterling has two 1500-hp 10-in. by 12-in. by 13-in. two-stage centrifugal units and one 1000-hp 10-in. by 14-in. by 16-in. single-stage centrifugal unit. The injection unit is a 200-hp electric-motor-driven 4-in. to 7¼-in. by 10-in. duplex power-piston pump. In addition, the station has a 150-hp "in-line" type, centrifugal pump that can be used as suction booster or injection pump. The main units are connected to operate in series. Sterling can pump 7400 bbl per hr when operating with minimum suction pressure and discharging at 1170 psi (line-limit).

The incoming Ft. Laramie-Sterling stream is monitored by a remote-reading gravitometer. Sterling has pneumatically operated control valve on the incoming line to maintain line pack. This valve may be remotely positioned by a signal from Sterling's control panel, or from Ft. Laramie.

Since Sterling was initially activated as a locally controlled station, all operations can be monitored and controlled from a central panel in the station's office. Ft. Laramie's operator usually has control, monitoring Sterling's operating conditions and starting or stopping units.

Herndon

This is the most interesting of these stations because unattended operation of the engine-driven units requires an involved local control design.

Herndon relays Sterling's pumpings. Attendance is on a

part-time basis for running-repairs and station housekeeping. Ft. Laramie starts and stops Herndon's units, guided by required throughput and telemetered operating data from throughout the section. As the flow rate and pressures of this section vary widely because of crude characteristics and injections, variable speed at Herndon serves to meet pumping requirements with minimum closed-system throttle loss. Guided by operating conditions at other stations, Ft. Laramie's operator can remotely adjust Herndon engine-speed to reduce overall throttling.

Herndon's engine room houses the gas engine driven auxiliary generating unit and air compressors along with the main units. Temperature is regulated with thermostatically controlled electric heaters. Ventilating fans maintain a slight positive pressure within this portion of the building. Two fans pump outside air into the conduits around each engine, from where it emerges through registers along either side of the unit. The air leaves the engine room through a roof-opening above each engine. The fans are started stepwise by thermostats on increasing engine room temperature and run only when the engine operates. To facilitate cold weather starting, engine room air is circulated from the heaters through the conduits alongside the units.

Anti-freeze solution is not used in the engine cooling system. The system above the roof drains automatically when the engine is shutdown, and fills automatically at the proper time following start-up. This automatic drain feature can be locked out during warm weather operation. The design provides no pre-start warm-up of engine lube oil or jacket-water.

An added feature of the cooling system is to be found in the radiator-fan drive. The pump supplying hydraulic power to the fan drive-motor is directly driven by the low-speed shaft of the gear at engine crankshaft speed. The hydraulic motor drives the fan through a worm-gear reducer. There is no temperature-controlled bypass valve in the hydraulic circuit. Jacket-water and engine lube oil temperature is regulated with bypass valves having built-in thermostats. In addition, shutters on the radiator frame are positioned automatically according to engine return-water temperature to throttle air passing through the radiator section.

In addition to the machinery protection previously outlined, capacitance probes monitor gear and engine lube oil for the presence of water, and shut the unit down if this fault occurs. There is a sump in the conduit at each engine to collect piping leakage. The engine is shutdown by a liquid-level switch when this sump becomes full. Engine room air is monitored continuously to detect the presence of an explosive mixture. The station is shutdown and isolated if this occurs.

Herndon's crude oil piping and manifolding is much the same as that at the electric relay stations. Although there is no discharge throttle valve, the station does have a small bypass control valve. This valve's function is to dissipate pump head while circulating at idle speed with the station isolated during scraper passage. Circulation through this loop prevents shutdown due to high case temperature.

Herndon normally operates on rpm control with station suction pressure, discharge pressure, and flow-rate override. When a unit is started, station flow and pressures are out of the critical range so that the rpm controller can command. A single pushbutton operation initiates the full sequence of events that places the unit on the line at idle speed. Assuming that the jacket-water system is drained, the sequence of events following a unit start signal is, roughly, as follows:

1. The rpm controller set-point motor advances the set-point from the shutdown position at 700 rpm.
2. The fuel oil solenoid valve opens.
3. If the engine has been completely drained, the drain valve closes.
4. The unit's hotwell pump (water make-up) starts and fills the jacket to the minimum water level — then stops.
5. The auxiliary lube oil pump starts.
6. When lube oil pressure rises to 5 psi, the unit's pump suction valve opens.
7. The suction valve's position starts the unit's discharge valve to open.
8. The discharge valve position completes a circuit to open a solenoid admitting the rpm controller output air to the rack-drive diaphragm motor, fully advancing the fuel racks. At the same time, a solenoid valve in the starting air line opens and the air-motor rolls the engine.
9. When engine speed reaches 300 rpm, output air pressure from the rpm transmitter shifts a solenoid to replace the full controller output pressure on the diaphragm motor with a fixed regulated air pressure sufficiently high to run the engine at slightly over 700 rpm. This prevents overspeeding before the rpm controller can respond.
10. At 500 rpm, the speed transmitter output air pressure trips switches to close the starting air valve, stop the auxiliary lube oil pump, and ready the ventilating fan circuit.
11. When the engine speed reaches and exceeds the rpm controller set-point, the controller output pressure drops. When the output reaches the fixed regulated pressure, a solenoid valve shifts to place controller output on the diaphragm motor, and the engine speed stabilizes at 700 rpm.
12. At 700 rpm, the speed transmitter output pressure trips a switch to ready the low lube oil pressure and excess vibration protective circuits.
13. When engine operating temperatures are safe, a panel lamp shows the engine ready for loading.
14. When jacket-water temperature reaches 150 F the water make-up pump again starts. After the system is filled to a level in the expansion tank, a liquid level switch stops the pump. Further water make-up is controlled automatically by level switches in the expansion tank.

Engine speed is adjusted by means of panel pushbuttons that operate the set-point motor to advance or retard the rpm controller set-point.

The engine starts on oil fuel and shifts automatically to dual-fuel operation as follows:

1. At 700 rpm with lube oil pressure above 25 psi, fuel oil pressure above 25 psi, and water temperature above 140 F, switches complete a circuit to open an electric valve in the gas supply line.
2. When the electrically operated valve opens, its posi-

ABOUT THE AUTHOR

V. L. Rupe received a BS degree in mechanical engineering from Oklahoma A & M (now Oklahoma State University) in 1934. Was with Reed Roller Bit Company for eight years, then for four years operated a general machine and welding shop prior to joining Stanolind Pipe Line Company (now Service) in 1947. Became an engineer in the mechanical section of Service Pipe Line in 1950. Since 1958 has been mechanical engineer, and in this capacity his work entails pump station design, economics of machinery selection, material and equipment specification and selection, and field engineering contingent with mechanical design and construction. He designed the mechanical installation and developed the basic control scheme of the stations described in this article.

tion trips a switch to open a solenoid valve in the air line supplying the pneumatic system to the gas controls.

3. Air pressure then opens a pneumatically operated valve in the gas supply line at the engine.

4. When gas pressure at the engine throttle valve reaches 40 psi, this pressure opens an air-relay feeding air to the throttle valve servo-motor and the throttle valve opens slowly.

A timer shifts the fuel system to straight oil, then back to dual-fuel at periodic intervals. Automation of the fuel gas system is so arranged that the engine's fuel gas supply is shut-off automatically when the engine stops, and remains shut-off with the system vented during the start-up.

A normal stop is initiated by depressing a pushbutton to effect the following sequence of events:

1. The rpm set- point motor drives through a timed run and the set-point stops at 500 rpm.

2. At 700 rpm, the speed transmitter output pressure causes the fuel gas supply to be shut-off. At 600 rpm, this instrument's output signal trips a switch to vent the solenoid in the diaphragm rack-drive supply line, retarding the racks and the engine dies.

3. At 0 rpm signal from the transmitter, switches trip to close the fuel oil valve and close the unit's pump suction and discharge valves.

4. When pressure in the engine lube oil system drops to 10 psi, valves held closed by this oil-pressure open to drain cooling water from the exposed system. As long as engine room temperature is above 35 F, the system drains only to below the roof line. At a lower temperature, a thermostat causes the main drain valve to open and the system fully drains to the hot-well.

Local and remote indications signal scraper passage and Herndon responds automatically during this event. The sequence is as follows:

1. Upon scraper arrival, the tripped incoming detector causes the station isolation gates to close and starts the rpm set-point motor to retard speed to 700 rpm.

2. Isolation gate position causes the bypass to open to permit circulation between the station's suction and discharge.

3. Scraper departure trips the outgoing detector, opening the isolation gates and closing the bypass valve. The engines remain at 700 rpm until the supervising operator adjusts their speed.

Any protective shutdown starts the same sequence of events initiated by a normal stop, except that the diaphragm rack-drive motor is immediately vented.

Laton

Laton is a 6000-hp, three engine-driven unit station designed to operate open or closed. The station is fully attended.

Three tanks are used to work the incoming streams from Herndon and West Kansas. Each tank is remotely gaged and served by a 150-hp in-line type vertical centrifugal booster. In addition, station suction pressure is supplemented by a fourth 150-hp booster of the same type.

There is a pneumatic control valve on the incoming line from Herndon to maintain line-pack. The position of this valve can be set remotely. Gravity of the incoming Herndon stream is transmitted to the office control panel to facilitate gate changes from that location.

Laton's engine control is similar to that at Herndon with slightly less automatic sequencing. In addition to controlling all local operations from a central panel, Laton's operator also monitors and controls stations on the West Kansas line, and Scranton station between Laton and Freeman.

Scranton

Scranton is another typical unattended electric relay station whose features have been described. The station is monitored and started from Laton, with local pumping control and protection. There is a single 2500-hp 12-in. by 14-in. by 15½-in. two-stage centrifugal unit at this location. The station is designed to accommodate a second unit.

Remote Control and Centralized Monitoring

This discussing covers only the Ft. Laramie to Herndon system. Control and monitoring of Scranton from Laton station is similar.

The Ft. Laramie to Herndon control and monitoring equipment is an all-relay system offering maximum security from false operation due to communication line interference. The communications circuit is a half-duplex, 0-15 cycle per second channel leased from American Telephone and Telegraph Company. All stations use the same facility and report in sequence to Ft. Laramie.

Controls at Ft. Laramie assigned to the supervision of La Grange, Enders, Sterling, and Herndon include:

1. Start unit(s) (all stations)
2. Stop unit(s) (all stations)
3. Reset unit(s) (all stations)
4. Raise and lower back pressure valve set-point (Sterling only)
5. Open and close station isolation valves (Herndon only)
6. Raise and lower rpm controller set-point (Herndon only)

Indications transmitted to Ft. Laramie and displayed by indicating lamps are:

1. Station isolation gates closed (all stations)
2. Unit isolation gates closed (at multi-unit stations)
3. Station low suction pressure (all relay stations)
4. Station high discharge pressure (all stations)
5. Station undervoltage, current unbalance (all electric relay stations)
6. Scraper passing station (La Grange and Herndon)
7. Unit(s) on (all stations except Herndon)
8. Unit(s) off (all stations except Herndon)
9. Unit(s) machinery fault (all stations)
10. Unit(s) fault with permissible re-start (Herndon)
11. Explosive atmosphere (Herndon)
12. Station ready (Herndon)
13. Unit ready to start (Herndon)
14. High tank(s) level (Enders)
15. Rate of change alarm for discharge pressure (all stations)
16. Loss of commercial power (Herndon)
17. Communications circuit failure (all stations)

Direct reading indications of telemetered operating data that appear on Ft. Laramie's panel are:

1. Station suction pressure (all except Enders)
2. Station case pressure (all electric relay stations)
3. Station discharge pressure (all stations)
4. Station flow rate (all stations)
5. Mainline stream API gravity (Enders and Sterling)
6. Station back pressure (Sterling)
7. Engine speed (Herndon)

Station discharge pressure is monitored for deviation and rate of change. A new set of data is sent to Ft. Laramie upon a deviation of 30 psi. If this change occurs within the pre-set limit of a rate-of-change timer, an alarm notifies Ft. Laramie that the station's pressures are changing abnormally fast.

The system has capacity for two future stations, plus the addition of a unit at each existing station, without adding communications channels. In addition, the system can be expanded, at little expense, to automatically log data with a typewriter, and to re-transmit this data to another location by means of teletype. ★ ★ ★

1 Metermen pick up orifice meter and temperature charts at gas purchase point . . .

2 Integrator operator, right, develops the extension of the orifice meter chart. She then writes all basic information on a key punch data chart printed on the back of the orifice meter chart . . .

COMMUNICATIONS AND CONTROLS

Computer Expedites Gas Accounting

Raw data are fed unit from as far away as 1200 miles via microwave and gas volumes returned within minutes

AN ELECTRONIC COMPUTER, fed raw data via microwave from as far away as 1200 miles, has centralized and expedited gas accounting for the Natural Gas Pipeline Company of America.

Utilizing the high speed of both the microwave and data processing systems, meter readings are sent to the Chicago home office from Houston and Amarillo, Texas, and gas volumes are returned within minutes.

These volume figures are especially important to the Texas production offices in cases where critical contracts specify minimum and maximum amounts of gas that must be purchased. They are also vital to compliance with production regulations of the Texas Railroad Commission.

Use of the centralized computer also has made it possible to handle increased business with less clerical personnel. Important reports are now more thorough, and are received more easily and quickly, without overtime.

Over 2 Billion Cu Ft Daily

Continental Construction Corporation, the forerunner of Natural Gas Pipeline Company, began building one of the pioneer long distance, high pressure natural gas pipelines in 1930. It was to extend from the West Panhandle field of Texas to Joliet, Illinois.

The pipeline was put into service October 16, 1931, with a designed capacity of 175,000,000 cu ft per day. By the end of 1948, recognized sales capacity was 510,000,000 cu ft a day.

In late 1951, NGPL's affiliate company, Texas Illinois, completed its 1400-mile line from the Texas Gulf Coast to Illinois to deliver an additional 374,000,000 cu ft daily into the Chicago market area.

According to most recent figures, NGPL has increased the daily capacity of the Natural Division to 830,000,000 cu ft and its Gulf Coast Division to 609,000,000 cu ft. These capacities, together with the 650,000,000 cu ft of Natural Gas Storage Company of Illinois, an affiliate, brings the total to 2 billion, 89 million cu ft, as metered.

800 Gas Purchase Points

NGPL maintains production offices in Houston and Amarillo.

At each of some 800 gas purchase points, an orifice meter measures the volume of gas flow and a temperature is recorded.

In most cases, the orifice meter chart is picked up by a meterman and sent to the measurement department and from there to the gas accounting department where all basic information is written on a key punch data chart printed on the back of the orifice meter chart. This includes: Meter number, date, Btu, gravity, average temperature, counter start, counter stop, average pressure, etc.

It is important to note that no volumetric calculations are necessary.

Using an IBM 26 printing card punch, this information is entered into an orifice meter daily input card — one card for each meter. These cards are fed into an IBM 66 printing data transceiver, which sends the information by private microwave to the Chicago office.

Houston and Chicago are microwave-connected by 40

3 This information is entered into an orifice meter daily input card by the operator of an IBM 26 printing card punch . . .

4 The cards are fed into an IBM 66 printing data transceiver, which sends the information on them by microwave.

for NGPL

relay stations; Chicago and Amarillo are linked by 17 relay stations between Chicago and Beatrice, Nebraska, and a private telephone system from Beatrice to Amarillo.

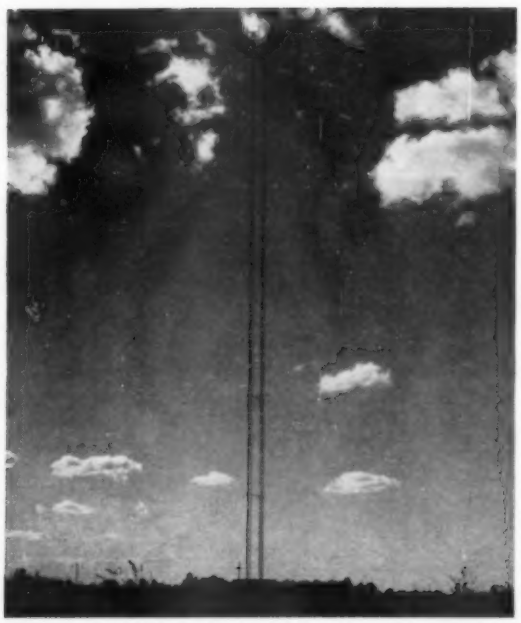
The transceiver automatically checks the information being sent out. In two years of operation, not a single transmission error has been permitted to enter the data processing system.

What Happens in Chicago

The information is received in Chicago on another printing data transceiver in the form of duplicate orifice meter daily input cards. The information punched into each card is also printed along the top of it.

These input cards are arranged in meter number order on an 82 sorter and merged on a collator with master orifice calculation cards, which contain all constant information for each of the meters—number, range, orifice plate, basic factor, etc.

The resulting deck is read into an IBM 650 data processing system through a cable-connected card read punch.



5 . . . through relay stations such as this, to Chicago where they are duplicated on another transceiver . . .

6 These cards are merged with master orifice meter calculation cards on an IBM 85 collator. The master cards contain all constant information for each meter . . .

The 650, which can perform as many as 250 operations per second, does all computations, makes numerous checks, and produces an orifice meter daily output card from its card read punch every 4½ seconds.

This output card contains the volume of gas and all data and factors used in its computation. The old manual system required about 8 minutes to arrive at each meter volume by looking up factors, multiplying and verifying.

The output cards are placed in the printing data transceiver and the information sent back to the originating production office where it is used to maintain contract requirements and regulations of the Texas Railroad Commission.

7 The resulting deck is fed into an IBM 650 data processing system through a cable-connected card read punch . . .

In Chicago, the deck is used to prepare a daily delivery sheet on an IBM 407 accounting machine. This triplicate report lists all deliveries by meter number. Two copies go to the measurement division.

A similar system is used for gas sales, except that the temperature and orifice chart from some 170 sales meters in the Chicago area are simply sent to the Chicago office where their information is keypunched into cards used by the computer.

The data processing system thus controls gas purchases accrual, gas purchases payment, gas sales accrual, and gas sales billing reports.

Previous to the present system, each production office calculated its own volume consumption and ran its own gas purchases payment reports.

Cards Used for Other Reports

The punched cards in the Chicago offices are also used for numerous other reports:

A summary delivery sheet is run off, by customer and area, including volume-to-date, by the 20-25th of the month.

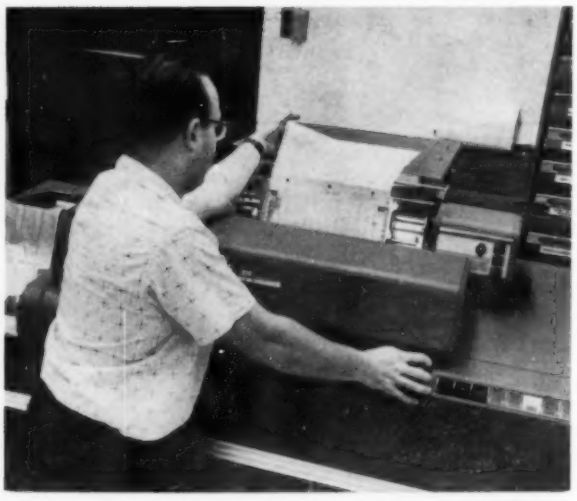
A division of royalties report each month lists the royalties for some 300 individual owners. Royalty checks and tax statements are machine-printed from the cards.

For sales customers, a gas sales summary gives up-to-date volume each week and a monthly report gives end-of-month totals by customer, by day. The latter goes to clerks who prepare invoices.

The computer is of special importance twice a year when orifice plates are changed to correspond to seasonal variations in consumption. Under the previous manual system, it took from 10 to 15 minutes of computation and verification for each of almost 75 meters. Now, the new orifice plate size is simply entered into the orifice meter daily input card and the computer makes all changes automatically.

Numerous other engineering and accounting projects are being handled by the computer and many more now in the development stage will be added in the future. ★ ★ ★

8 Every 4½ seconds the 650 computer produces an orifice meter daily output card containing the gas volume . . .



9 These output cards send volume statistics back to the production office via transceiver. Then they are placed in this 407 accounting machine to print daily delivery sheets.

Instrumentation, Controls, and Automation

Part 5: Telemetering

MAX T. NIGH

Digital Telemetering . . . Language Patterns

Introduction and Definitions for Digital Telemetering

Up to this point in this series of articles, we have been discussing analog telemetering and pulse signals. We have described the terms proportional and pulse-duration. We have also been setting the stage for "digital" telemetering systems by providing the reader with a graphical tool for visualizing message patterns as transmitted over a communication system. If these concepts are not usable at this reading, a review of Parts 1 through 4 would be in order. Let us start by defining some terms.

Bit. This is a binary digit. In the binary numbering system only two conditions are possible, either 0 or 1. Thus a bit is characterized as existing in one of two possible states.

Character. An element of any word representing a numeric or alphabetic digit.

Word. A group of characters representing one piece of information. In computers this would be a group of characters occupying one storage location.

Message. Composed of a group of characters or words permitting complete definition and identification of the measured value or one piece of information.

Resolution. Smallest increment that can be detected or observed by a measuring instrument (transducer) or message handling system. Usually expressed as percent of the maximum magnitude of the measured quantity.

Accuracy. Degree of reproduction of a measurement by a transducer compared to the true value, expressed as percent of full scale of the transducer or measuring element.

Margin. In digital telemetering we use this term to represent the ratio between any mechanical, electrical, or time representation of a binary bit 0 and 1. A high ratio (i.e. 4:1) signifies a good engineering design in terms of variation in quality of components, environment, etc. The objective always is to be the detection between 0 and 1 correctly and reliably.

Parity. Evaluation of number of bits of one state in any character determining portion of the word and adding another bit of this same state to assure an odd or even count of bits in one state, for the character, word, or message.

These terms have been defined for our use in further discussion. A complete and correct list of definitions can be found in the following:

1. ASA C42.30-1957—Definition of Electrical Terms

2. ASA C37.2-1956—Automatic State Control, Supervisory and Telemetering Equipment.

Language Patterns for Telemetering Machines

Digital systems are designed to transmit information by sending a series of "yes" and "no" types of signals which can be interpreted (decoded) at the receiving end with equipment or people that know the "rules of the game." This is the commonly referred to binary system of counting. In digital telemetering we do not follow the rules of mathematics as related to the binary system, but rather, establish our own "rules of the game." We are now referring to the language of the digital telemetering system. Each manufacturer has a different language pattern for his digital telemetering system. This has come about through natural selection, evolution from simpler systems, and an effort by each manufacturer to be distinctive, or to be conservative in avoiding possible patent infringement difficulties.

We cannot show all these different systems, since we want to use the reader's time expeditiously and our charge at the start was to provide the concepts of telemetering and not an encyclopedia.

We are going to discuss only the principal ones in use and also those which cover a particular concept. An encyclopedic study can be made by reading the report, *Data Transmission for Centralized Operation of Control and Telemetering Systems*, prepared by the Data Handling Group Pipe Line Committee, Transportation Division, Instrument Society of America. This report is an attempt at education and recommended standards for language patterns as used in Data Acquisition systems in the petroleum industry. The credit for this contribution belongs mainly to Dave Wolkov, Technical Consultant to Cutler-Hammer Airborne Instruments Laboratory of Deerpark Long Island, New York. A discussion of this report and recommended language standards will be covered after the principal languages have been discussed.

Time Code Language Patterns

In developing these "yes" and "no" type of message patterns, a good one to pick first is the coded systems which use the time duration of a pulse to establish the yes or no intelligence. This is much like time duration or pulse duration analog telemetering, except our only objective is to distinguish between a yes and a no as represented by the duration of a pulse.

The only limitation we have with this approach is the technique we employ to distinguish the "yes" information from the "no" information. In order to provide this with the maximum security a method used with pulse duration system is to have the "margin" or difference between the yes and no bits be in a ratio of 4:1. Early in digital telemetering system applications a 2:1 ratio was found to be lacking and most systems have gone to a margin of 4:1 or approaching 4:1. This ratio provides us with the same assurance in engineering design we associate with building or bridge construction. Engineers are almost always conservative and place "margin" in any of their designs to provide assurance of any system working even under adverse conditions.

We can now turn our attention to the pattern created by sending a series of such yes and no bits over a communication system. Fig. 17 shows two different types of time coded patterns.

Information on Tone-On Period Only

The upper pattern transmits information only during the "tone-on" period. Note that the "tone-off" time period is the complement of the "tone-on" time period. Here we have shown a basic cycle of 400 milliseconds. The 300 millisecond "tone-on" time period is a "yes" and the 75 millisecond "tone-on" period is a "no." Often this type sequential pattern is commutated by a synchronous motor as the rotating device. This pattern is used in a tank gaging system by Vapor Recovery Systems of Compton, California.

I think it is obvious the "tone-off" and "tone-on" positions could be reversed and the system would provide the same transmission intelligence. The decision is a choice of the systems engineer and the communications engineer.

Information on Both Tone-On and Off Periods

A different time coded pattern is shown in the bottom portion of Fig. 17. Here yes and no information is transmitted by varying the length of both the "tone-off" period and the "tone-on" period. Here we show the "yes" time period being 350 milliseconds and the "no" time period as 100 milliseconds. This applies to both the "tone-on" condition as well as the "tone-off" condition. Also note there is no basic cycle — no evenly generated repetition of yes or no and its complement. This means the generation of the pattern is completely dependent upon the order of the yes and no information. The reception of this information is also dependent upon the receiver detecting each yes and no correctly as well as preparing itself for the next bit of information. This pattern is used by Union Switch and Singal Company of Swissvale, Pennsylvania.

Time Code Pattern Using Time Pulse Position

A third popular language pattern is very similar to standard teletype. It is used for transmitting alphabetic as well as numeric information. Fig. 18 shows the pattern of this type of system language. It could be described as a non-return to zero transmission system. There is no basic cycle within the message and each bit does not start with the line circuit being in the same state before the start of the next bit. This pattern is used by Dresser Electronics of Houston, Texas. To amplify — each bit is given a specific position in time beyond the start pulse, with the status of the line circuit to indicate if that bit is meant to be a 0 or a 1. This 0 or 1 is referring to the binary or two-state method of counting. In telegraphic practice, the two states of the line circuit are mark and space. The mark can be referred to as 1 and the space condition allude to a 0.

If we assign each bit a given value (this is often referred to as weighing each bit), we can easily characterize any decimal number between 0 and 9, with only four bits. The weighting factor is the powers of 2 with the powers of 2 being the number of bits. Thus $2^0 = 1$, $2^1 = 2$, $2^2 = 4$, and $2^3 = 8$. With each bit assigned weighting values of 1, 2, 4, and 8 we have what is sometimes called a binary coded decimal code pattern. If the bits are all spaces — with no

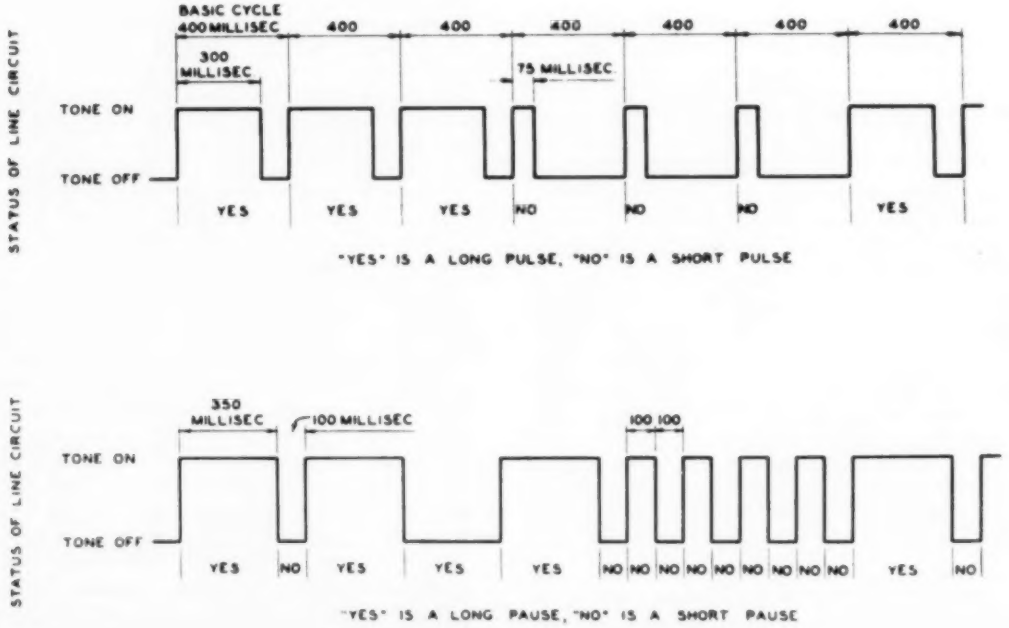


FIG. 17. Time code information patterns.

marks – the message has been 0, 0, 0, 0, and contains no positive information.

A very good exercise to clinch the principle discussed is to set up a pattern of four bits with each bit either 0 or 1 and establish the validity of the proposition that any number between 0 and 9 can be characterized with these four bits.

Parity as One Security Technique

The basic word is made up of a start pulse, the four bits signifying 1, 2, 4, and 8 with a fifth bit followed by a stop pulse. This fifth bit is a "parity" bit, which is one of a number of security techniques used to guarantee the correct reception of each character in the message. Circuitry is designed at the transmitter to cause the fifth bit to be a 1 if the number of bits required to characterize the decimal number is even. The "rule of the game" here is for the word to always contain an odd number of bits in the mark condition.

This technique is very useful in matching digital telemetering systems to other data handling systems such as computers. If the parity bit is checked after the information is transferred from one system to the next, a check on the correct transfer is made. In machine language this is a tool of control like double entry bookkeeping or cross-footing in accounting.

Characterizing an Analog Measurement

Most analog measurements made in industry are adequately characterized by 3 decimal digits. The accuracy associated with most measuring devices is ½ of 1% full scale, with some instruments being ¼ of 1%. The accuracy level of ¼ of 1% provides a resolution, in terms of the accuracy, of 1 part in 400. If we transmit digital values representing these measured quantities, with a digital solution of greater than 1 part in 400, we are preserving all the accuracy that is possible in any measuring device. Three digits provide a resolution of 1 part in 1000, which is more than adequate to meet the requirements. The lower portion of Fig. 18 shows the transmission of three decimal characters. The lower portion of the figure presents the pattern associated with the characterization of a three-decimal digit number, 137. This could be the pressure in a pipeline, the flow rate, or the temperature, albeit a bit high for temperature.

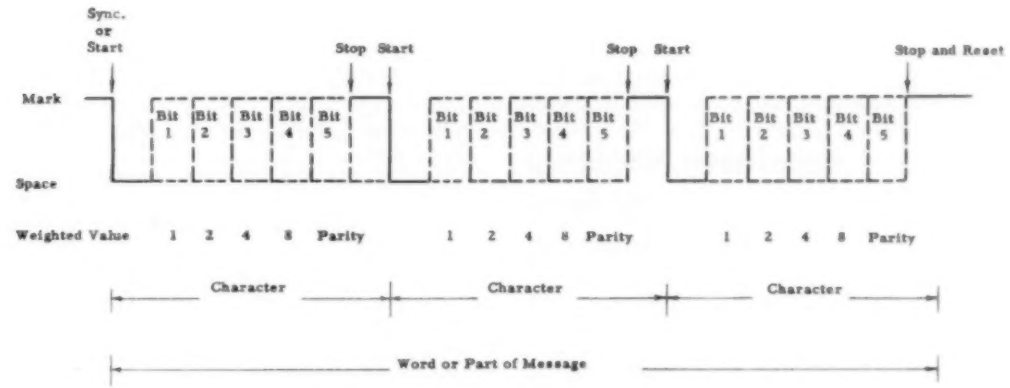
Alphabetic and Numeric Information by Time Position Pattern

With four bits in each word we can characterize any number between 1 and 10, or 0 and 9, depending on your choice of scale. Four bits do not permit us to characterize enough additional characters to include all alphabetic and other signs used in business.

Teletype Baudot Code

The teletype system or Baudot Code uses 5 bits for alphabetic and numeric information. In the teletype there are 52 total characters with 5 control characters. We should not be able to produce this many combinations from 5 bits, since $2^5 = 32$. The problem is avoided by having one group of 26 letters and a separate group of 26 symbols and numbers that are identical in pattern to the alphabetic characters. By sending a control character at the start, the characters following are supposed to be in the group specified. This is not a system with good validity or security. Communication noise and interference can create considerable difficulties in message characterization. Each character does not have its own definition as part of its individual pattern.

Its use in teletype has been very successful for alphabetic messages as there is considerable latitude with letters in words without destroying the meaning of the message; not so with numbers being transmitted from machine to machine. The teletype language pattern is not a secure one, and a number of techniques have been used to cover up its shortcomings. One is the retransmission at the bottom of each message. Another is to totalize the digits in any row of digits and send this total to permit an accounting type control on the information.



BASIC STRUCTURE OF ONE TYPE PULSE POSITION LANGUAGE

NUMERIC DATA ONLY

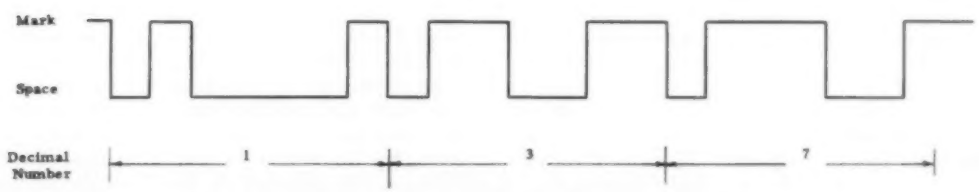


FIG. 18. Typical digital transmission representing an analog measurement.

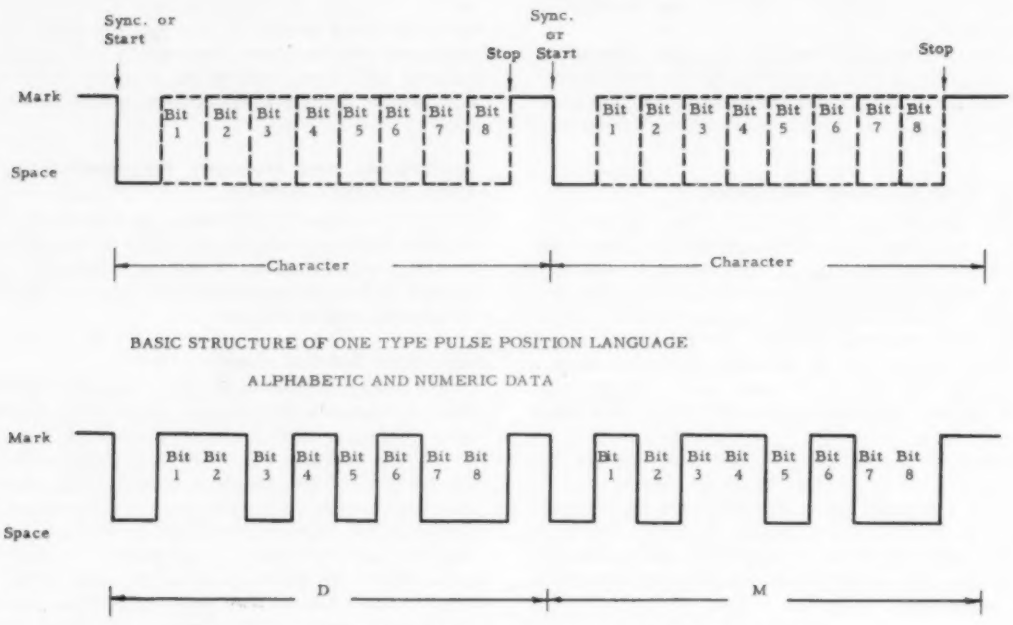


FIG. 19. Typical digital transmission representing two alphabetic characters.

IBM Transceiver Code

Another means of increasing validity would be to define each character within its own number of bits and provide a parity check as we did with the numeric information. This can be done with eight bits for each character.

One such system is shown in Fig. 19. Here each character is made up of eight bits. It provides for a parity type of check by restricting the patterns such that there are always four mark bits and four space bits in each character. A total of 54 alphabetic, numeric and signs are characterized with this system. It is a popular message pattern used for transmitting information from cards to cards in data handling systems associated with card fed computers. It is known as the IBM Transceiver Teleprocessing system. The lower portion of Fig. 19 shows the characterization of the letters D and M. I suggest the reader check the security technique in the pattern to see if four mark bits and four space bits have been used with each character.

Bits, Characters, Words, and Messages

We have defined these terms and have used bits to make characters, characters to make words, and the next step is to put these together in the form of messages. The next part will discuss in detail messages utilizing the different language patterns we have discussed. ★ ★ ★

Automatic Welding Without Pipe Rotation

A NEW PROCESS that solves the problem of automatic welding without rotating the pipe, and makes automatic welding in the field a reality, has been developed through Esso Research and Engineering Co.

The key to the process is a welding device that clamps over and welds two lengths of pipe 20 times faster than is possible with hand welding techniques. Only three men are needed — a welding technician, his assistant, and a tractor driver.

The process and the automatic welder are the result of several years' research and development work, says M. J. Dabney, head of Esso Research's pipeline research program. The welder, which has undergone a six-month evaluation and a successful field test in West Texas during actual construction operations of Humble Pipe Line, is designed for use with 4, 6, and 8-in. diam pipes, but can be adapted for 30-in. and larger pipe.

Cooperating in the research were the Battelle Memorial Institute and the Air Reduction Sales Company. Crutcher-Rolfs-Cummings participated in the development work.

These are the basic steps in the new process:

Pipe is strung along the ditch. The tractor aids in lifting pipe to be welded and in placing the automatic welder over the pipe ends. The ends are held firmly together and in line by means of a specially devised Crutcher-Rolfs-Cummings internal alignment clamp. After the weld is completed, the clamp is collapsed and withdrawn to the next joint.

When the automatic welder is in position over the pipe ends, it firmly clamps in place with its dual prongs. An air-driven abrasive cutting wheel then slices a minute sliver from each of the pipe ends. It does this in two circular sweeps. An arc welder follows in the track of the cutter and makes the weld. The continuous process needs only two motions of the cutter and two of the arc welder to do the job. On 8-in. pipe the weld is completed in one minute.

Corrosion practices

MEASUREMENT OF COATING LEAKAGE CONDUCTANCE

PART 2 — CONCLUSION

MARSHALL E. PARKER
Consulting Corrosion Engineer, Houston, Texas

Measurement Methods

Some essential differences between actual lines and the simplified model we set up force upon us some necessary techniques. Because there is likely to be some current flowing in the line at any point, and because there is sure to be *some* potential between the line and whatever we choose as the best possible substitute for the mathematical fiction, remote earth, steps have to be taken to disentangle the currents and potentials of our experiment from the fortuitous quantities present. To do this we drain from our structure an *interrupted* current, and we observe the effect of this interruption. The change in current is called ΔI; thus the change in the drainage current itself would be ΔI_0 (from one direction); the change in the observed current flow in the line at distance x from the drain point would be ΔI_x. In similar manner, the change in potential at the drain point would be recorded as ΔE_0, and at distance x would be ΔE_x.

It is desired that the observed ΔE at any point be free from polarization effects; that is, we want the instantaneous change in potential produced when the current is changed, with no time allowed for polarization. Experience has shown that the best way to get this is to observe the change as the current comes on, rather than the drop in potential as the current is turned off, although theoretically either should give the desired value. Both experience and good instrumentation are required to get this value accurately; it is often necessary to observe several changes to get a good value.

Another source of error to be avoided is that due to anode proximity. In the derivation of expressions for attenuation, it is assumed that the current that is drained is discharged to remote earth through a zero resistance; in other words, there is no potential gradient around any anode. In an actual case, there is a potential gradient that must be avoided; the anode location must be such that no part of the line section under test is within the gradient, or an error in the value of ΔE will result. As the anode gradient is theoretically unbounded, what this means is that test section must lie so far from the anode that the gradient is negligible.

Case 1 — Long line, slope method. A "long line" in this case means one so long that the initial portion is indistinguishable from an infinite line. This means that ΔE will plot on semi-log paper as an essentially straight line, once the anode gradient near the drain point is passed. This can be determined by inspection of an actual plot of at least three values of ΔE; four or more gives an added factor of safety.

If current is drained across an insulated joint, either by use of a battery booster or by taking advantage of an existing difference in potential, the anode will be sufficiently remote that the drain point can be used as one value of ΔE; otherwise it is usually necessary to omit this one value from the calculations.

The value of α is determined by the use of Equation 11, using any two values of ΔE lying on the straight line obtained. Then k is found from Equation 8. The value of r to use in this equation may be known already, may be calculated from the pipe weight, or may be determined as explained later.

Case 2 — Long line, $\Delta I/\Delta E$ method. This method uses the basic definition of conductance given in Equation 2. A section of line is selected, and current measuring spans are established at each end (see below). Current is drained from a point far enough from the end of the section to escape the anode gradient, and ΔE is observed at each end of the section, as is ΔI. The total current flow to the section is the difference between the two values of ΔI; the problem then is to determine the true average value for ΔE. If the two values of ΔE do not differ by a ratio greater than 1.6, the arithmetic mean of the two will be within 10% of the true mean; if the ratio is greater than 1.6, then the section must be subdivided by additional ΔE readings; averages are then obtained for each sub-section, and the average for the whole section will be the weighted average of the subsections.

The shortest section that can be done by the described method would be the one whose two ΔI's were just different enough to yield a reliable difference; the maximum section depends on the accuracy with which the smallest value of ΔE can be read. In the simplest case, where two readings are taken of both ΔI and ΔE, the total conductance is given by:

$$K = \frac{2(\Delta I_a - \Delta I_b)}{\Delta E_a + \Delta E_b} \quad . \quad . \quad . \quad . \quad . \quad (16)$$

This is applicable, as explained above, only when the section is short enough that the arithmetic mean between

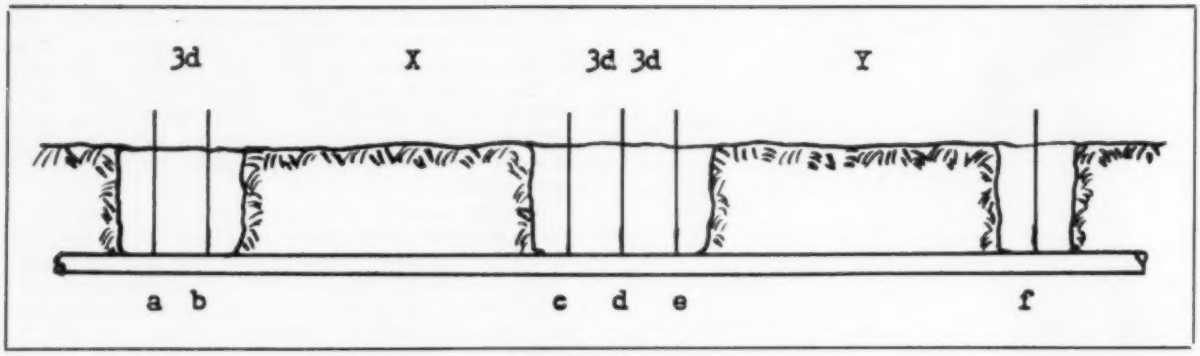


FIG. 2. Spacing of test leads for calibration of test section.

the two ΔE's is a sufficiently close approximation of the true mean value. Once the value of total conductance K is obtained, the value of k can be had by dividing K by the length of the section in megafeet.

Case 3 — Long line, modified $\Delta I/\Delta E$ method. Where current is drained across an insulated joint, the value of ΔE_o may be used in the preceding formula, as anode proximity effects are avoided. In this case, it is also possible to measure ΔI_o directly with an ammeter, instead of by the more cumbersome IR drop method. Equation 16 is then used as before.

Case 4 — Long line, R_o method. This method is applicable only where current is drained across an insulated joint, and does not make use of any line current measurement except for ΔI_o, which is measured with an ammeter. The initial slope of the line must be straight for this to be at all applicable. The value of α is determined as in Case 1. R_o, the input resistance of the line, is given by:

$$R_o = \Delta E_o/\Delta I_o \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (17)$$

which is merely Ohm's law in a particular instance. We have also, from attenuation theory:

$$R_o = r/\alpha \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (18)$$

This expression makes it possible to calculate r without recourse to field measurements or to information about the pipe. The possibilities for error are large in this method, and extreme caution is urged in its use. It is not recommended unless the value of αL is at least 2.8 or 3.

Case 5 — Short line, attenuation method. If the line is short enough so that the ΔE obtained at the far end (insulated) is large enough to be measured with acceptable accuracy, then the attenuation constant α can be determined by measurements of ΔE alone. This length requirement applies to the section of line between the end and the last prior point of measurement; it does not make any difference how much line lies the other side of the drain point. These requirements will, in general, be met by a section of line for which α L is not greater than 4.6; this means a ratio of maximum to minimum ΔE of about 50:1.

Current is drained from the line, and ΔE measured at the end, and at one other point between the drain point and the end (may be at the drain point, if anode proximity can be eliminated). The attenuation constant is then determined from a modification of Equation 15:

$$\cosh \alpha L = \Delta E_a/\Delta E_L \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

The value of k is then found from Equation 8; r may be known, or may be calculated from pipe weight or determined by measurement in the field.

Case 6 — Short line, R_o method. This is the same as the preceding case, except that r is determined from the direct indication of R_o, as in case 4. Anode gradient must be avoided, and a direct measurement of ΔI_o must be taken. R_o is calculated from Equation 17 as before, but r is obtained from:

$$R_o = (r/\alpha) \ (\coth \alpha L) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (20)$$

Caution is advised, as the possibility of error is large. Like case 4, this method is most useful as a check where another is also used.

Case 7 — Short line, $\Delta I/\Delta E$ method. In a terminated line, if the final value of ΔE is large enough to be useful, only one value of ΔI is needed, since ΔI_L is clearly zero. The principal problem is obtaining a true average of ΔE. This can be done by the use of correction factors, as tabulated below. The larger the ratio between ΔE_a and ΔE_L, the larger is the error in taking the arithmetic mean of the two as the average ΔE. If, however, the arithmetic mean is multiplied by the correction factor given below, as a function of the ratio $\Delta E_a/\Delta E_L$, the true average will be obtained.

$\Delta E_o/\Delta E_L$	factor	$\Delta E_o/\Delta E_L$	factor	$\Delta E_o/\Delta E_L$	factor
1.0	1.000	1.7	.908	2.4	.843
1.1	.983	1.8	.896	2.5	.835
1.2	.970	1.9	.886	2.6	.829
1.3	.955	2.0	.876	2.7	.821
1.4	.942	2.1	.868	2.8	.814
1.5	.931	2.2	.860	2.9	.809
1.6	.920	2.3	.851	3.0	.802

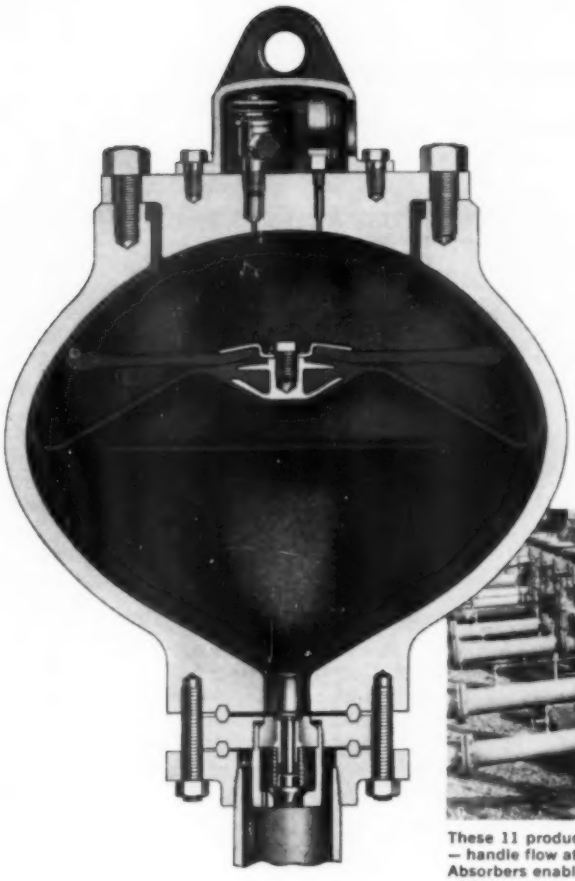
For values lying beyond the range of the table, α can be obtained from Equation 19; then the following expression gives the true average potential:

$$\Delta E_m = \Delta E_L \frac{\sinh \alpha L}{\alpha L} \quad . \quad . \quad . \quad . \quad (21)$$

There is little choice, of course, between this roundabout method and direct application of the attenuation equations.

Case 8 — Very short lines. A very short line is defined as one so short that the values of ΔE are not significantly different at the two ends; i.e., there is no appreciable attenuation. Clearly, in such a case, attenuation methods cannot be used, and the calculation must be by the direct $\Delta I/\Delta E$ method. Usually, it will be necessary to measure ΔI_o by ammeter, as it will probably be too small to measure by IR drop methods. The method, then, is the same as the foregoing.

prolongs life of pipelines, fittings and pumps... saves downtime... cuts maintenance costs!



These 11 product transfer lines — some over 1,000 feet long — handle flow at the rate of 1,600 gpm each, yet Hydril Surge Absorbers enable them to be closed in a fraction of a second without over-pressuring lines, fittings or metering equipment.

HYDRIL TYPE "K" SURGE ABSORBER

smooths out shock and pulsation in pipelines

QUICK-CLOSING VALVES and piston-type pumps punish pipelines by imposing sudden peak pressure loads. Unless these surges can be absorbed or smoothed out, pipe and fittings are exposed to stresses which may cause costly failure.

Hydril Type "K" Surge Absorbers are successfully controlling many types of line surge and pulsation in petroleum product handling lines, water pumping systems and oilwell repressuring programs. Simple design and construction assures long, trouble-free operation. This same oil field-proven Hydril design has been used for many years as a pulsation dampener on high-pressure oilwell mud pumps. Servicing, though rarely required, is readily performed without special tools and without shutting down the system or removing the unit from the line. Available in a wide range of sizes and pressure ratings.

Another dependable Hydril pressure-control product

For more detailed information on Hydril Surge Absorbers, consult your Pipeline or Composite Catalog... or call your Hydril Representative

HYDRIL COMPANY

734 West Olympic Boulevard, Los Angeles 15, California

Factories: Los Angeles, Calif.; Houston, Texas

Calibration of Test Section

For the determination of the resistance of a length of pipe under the most general conditions—out on the line, away from all insulated joints—a total of six test leads in three excavations is required, spaced as shown in Fig. 2. The leads "b" and "c" are the permanent leads between which the resistance R is determined; after the calibration, the others may be removed. The use of contact bars is not, however, recommended; all leads should be welded to the line.

Spaces indicated by "3d" between leads ab, cd, and de, should be at least three pipe diameters; somewhat more is permissible. The spans X and Y should be measured carefully, and may be equal; calculation will be simpler if they are equal. X and Y should be long enough to give an easily measured potential drop for the current to be measured. This, of course, depends upon instrumentation. A rough guide is to make these distances at least twice as great, in feet, as the pipe weight in pounds per foot; four times is better.

Current is passed through the leads a and d; this current is interrupted, its value being designated as Δi. The change in the potential between b and c is observed as this current is interrupted; this change is designated as Δe. At the same time, or upon a repetition of the same Δi, the potential change over the span e to f is observed, and designated as $\Delta e'$. The purpose of this Y span is to detect any "end losses," or currents completing the circuit by flowing the long path through the earth. If Δi is measured in milliamperes and the Δe's in millivolts, then the resistance R of the section is given by:

$$R = \frac{\Delta eY + \Delta e'X}{\Delta iY} \quad . \quad . \quad . \quad . \quad . \quad . \quad (22)$$

If Y = X, this expression simplifies to:

$$R = \frac{\Delta e + \Delta e'}{\Delta i} \quad . \quad . \quad . \quad . \quad . \quad . \quad (23)$$

Finally, if there is no end loss, i.e., if $\Delta e' = 0$, then

$$R = \frac{\Delta e}{\Delta i} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (24)$$

If the measurement can be made close to the end of a line, where there can be assurance of no end loss, leads e and f can be omitted; if there is a valve or other fitting above ground, then either a or d can be omitted, by using a temporary connection. Spans X and Y must always be straight welded pipe, with no fittings or joints of any kind within their length.

The very small potentials involved must be measured with extreme care. If a millivoltmeter is used, then corrections must be made for lead resistance. A potentiometer that will read to hundredths of a millivolt is the preferred instrument. Care must be taken even to avoid much temperature difference between various bimetallic joints in the circuit, for the thermo-electric effects can be a substantial portion of the potential being observed. If leads are attached to the pipe by the thermite process, at least half an hour should be allowed for them to cool, and all of the welds should be in the shade when the readings are taken; it is even better if they are all buried.

The value R obtained is the resistance in ohms between leads b and c; to obtain r, this must be divided by the length X expressed in megafeet. The reciprocal of R, which may be designated as K, is useful when the span is used to measure current; it may be expressed in amperes per millivolt. ★ ★ ★

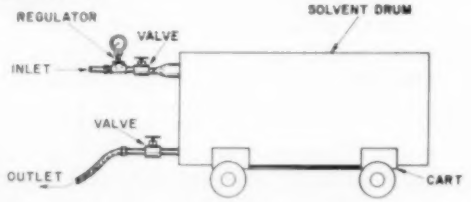
IDEAS AT WORK

Locking device protects valves

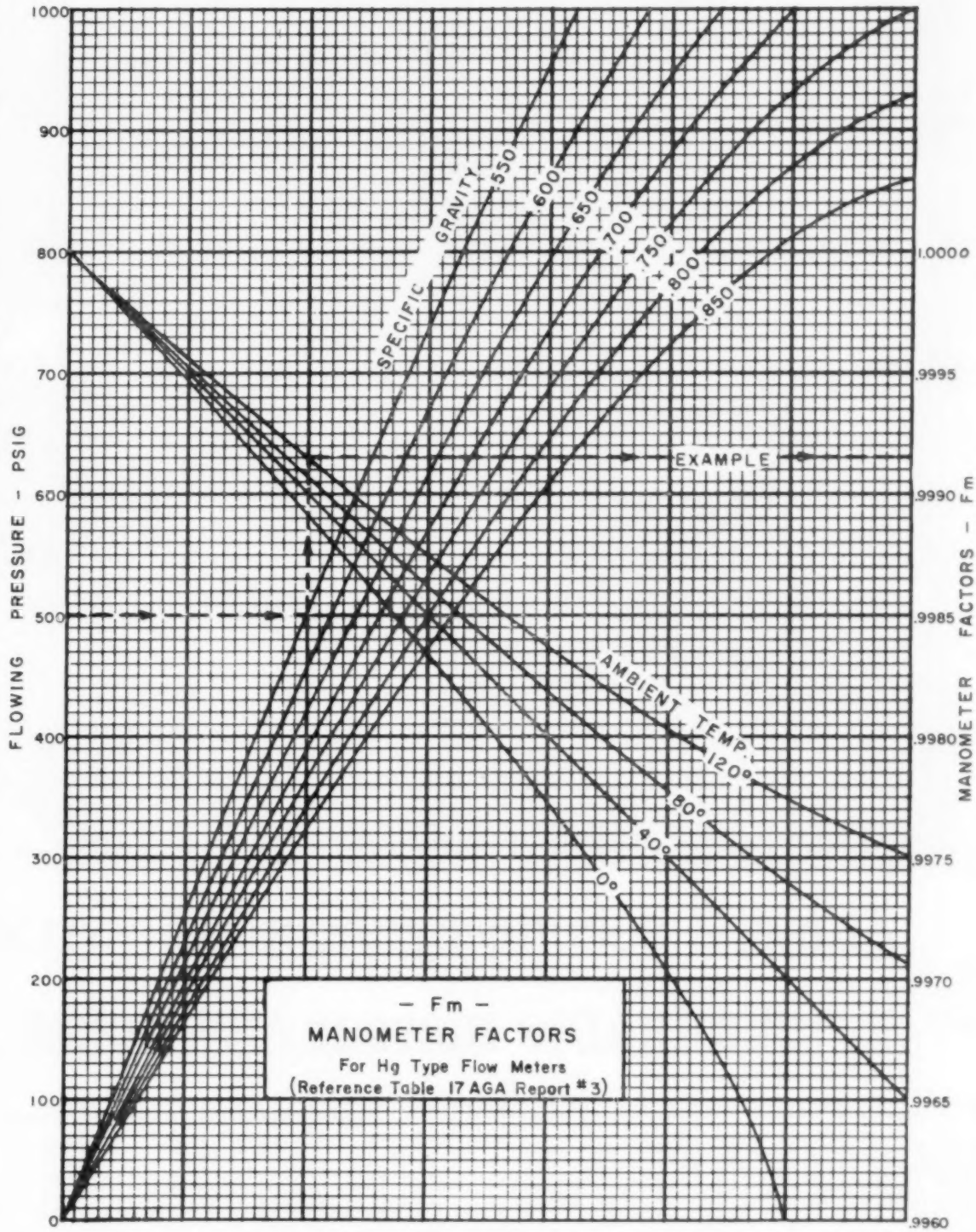
In locations where it is necessary to protect valves from intruders, or where it is desired to keep unauthorized personnel from operating valves, a simple locking device can be made from scrap iron and scrap pipe. Using a piece of pipe large enough to cover the valve operator, weld an ear onto the pipe, with a hole in it large enough to hold a company lock. Then weld a length of chain to the opposite side of the pipe. Put the wrench or wheel onto the chain and run the end of the chain through the lock. Make sure the chain is tight enough when wrapped around the bottom of the valve to hold the cover in place. To protect the valve operator from rain and weather, weld a piece of scrap plate to the top of the piece of pipe.

How to reach inaccessible engine parts with solvent

When overhauling engines, dirty parts are sometimes hard to reach. In order to spray solvent on the inaccessible parts, install a pressure connection on the solvent drum. An air line is connected to the top of the drum through a regulator set at 5 psig. A valve at the bottom outlet of the drum controls the flow of solvent through a hose attached and equipped with a fine spray nozzle. A portable cleaning unit can be had by making a cart of scrap iron and casters or wheels.



Manometer Factors for Hg Type Flow Meters



new, 2-second cycle, all-electronic eliminates mercury switches...

A giant step forward in the science of telemetering measured variables — this is Foxboro's new telemetering system.

Completely electronic, the system abandons earlier mechanical means of producing a pulse-duration signal. Dry reed switches replace troublesome mercury switches . . . a photo-diode switch replaces the mechanical cam switch. There are no synchronization problems . . . no vacuum tubes . . . no periodic maintenance.

Standard impulse-duration cycle on the new Foxboro telemetering system is 2 seconds — 4 times as fast as any other standard system. The signal can be carried over any

FOR FURTHER INFORMATION ON
ADVERTISED PRODUCTS, SEE READER SERVICE CARD

telemetering system makes maintenance "plug-in simple"

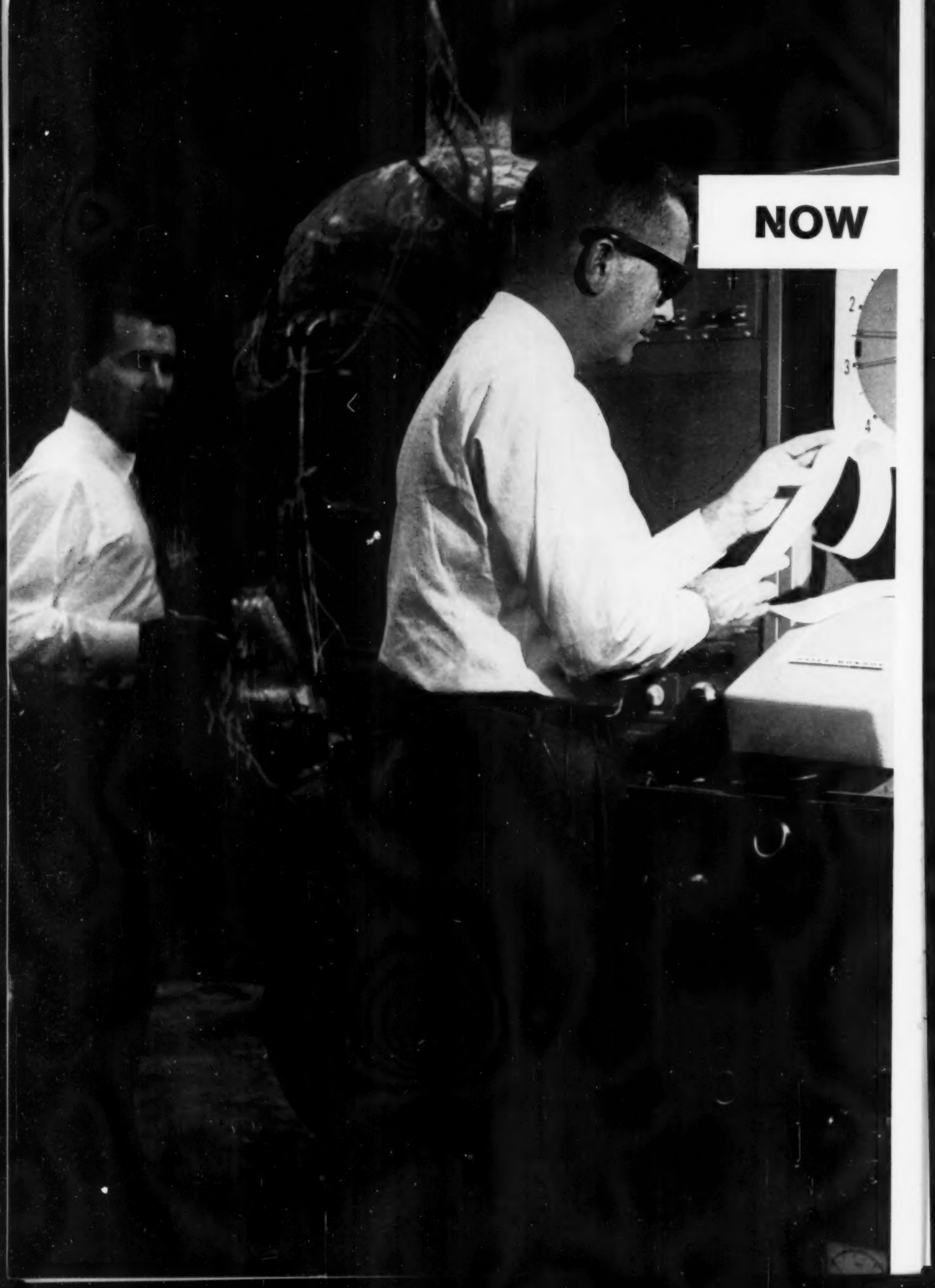
transmission medium. Modular construction makes servicing easy as "plugging-in" a new component.

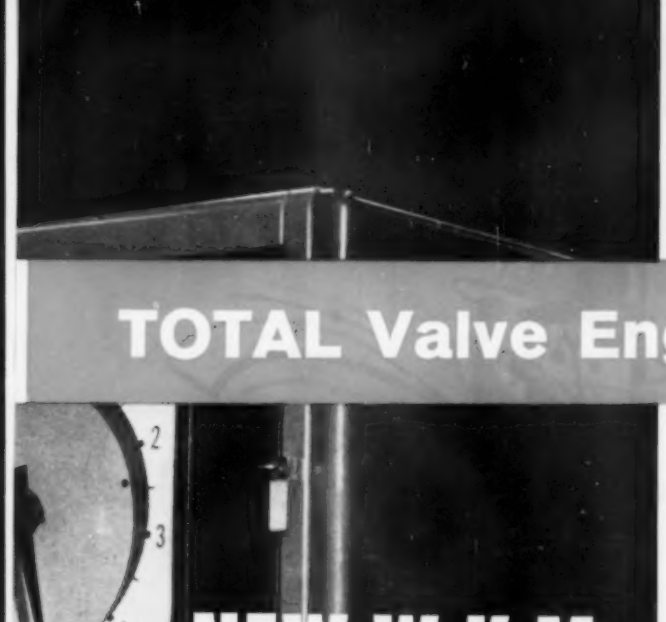
This is the telemetering system all industry has been asking for. For full details, write for Bulletin 17-12. Or better yet, ask your Foxboro Field Engineer for the complete story. The Foxboro Company, 384 Norfolk Street, Foxboro, Mass.

FOXBORO

REG. U. S. PAT. OFF.

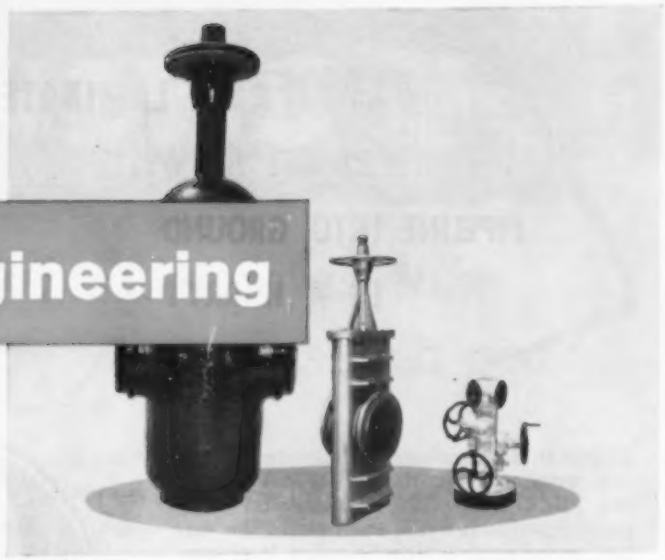
*Reg. U.S. Pat. Off.


NOW



TOTAL Valve Engineering

NEW W-K-M COMPUTER PREDICTS PERFORMANCE



Left to right above, W-K-M's new: *Safe-T-Seal* Gate Valve (ASA); Pressure Sealing Gate Valve (ASA); Cross-type Triple Gate Valve (API).

Unique strain gauge analyzer pre-solves your valve problems

In *seconds* it gives answers that used to take *days*. This unusual digital logging computer developed to W-K-M engineering specifications finds out what will happen to a valve under every conceivable service stress.

The W-K-M computer measures strain, applies corrections for temperature, test material and gauge factors, and prints the results of its stress calculations. It can analyze 40 areas of a valve in less than 40 seconds!

Advanced research is an important part of TOTAL Valve Engineering—W-K-M's unique dedication to *all* phases of valve technology. Another reason why W-K-M Valves perform better, last longer . . . on the world's toughest jobs.

W-K-M

DIVISION OF ACF INDUSTRIES
INCORPORATED
P. O. BOX 2117, HOUSTON, TEXAS

6008-R

PLICOFLEX LAMINATED PIPE PROTECTIVE TAPE

HELPED GET MIDWESTERN PIPELINE INTO GROUND IN A HURRY!

20,000 ft.-day average taping rate of progress with a record day of 28,000 feet on the Midwestern Gas Transmission Company pipeline is a fine example of the ease and speed with which Plicoflex laminated vinyl-butyl tape goes onto pipe to get it into the ground . . . fast.

Ease of pipe preparation and ease of tape application with a minimum of equipment as well as Plicoflex's proven pipe protection make it your best buy in protecting pipe, above or below ground.

Application is simple . . . all you need to do is

Give the pipe a good wire brushing

Apply the primer (at prevailing temperature)

Wrap the tape and ditch the pipe. All this in one operation!

Plicoflex protects your pipe because its—moisture proof • nonconductive • impact resistant • bacteria proof • abrasion resistant • soil stress resistant • chemical resistant.

PLICOFLEX, INC.

2425 Mowery Rd. P. O. Box 45911 Houston 45, Texas
JAckson 6-3711 Teletype HO 277

10 colors, 4 thicknesses available. Write for descriptive literature or demonstration.

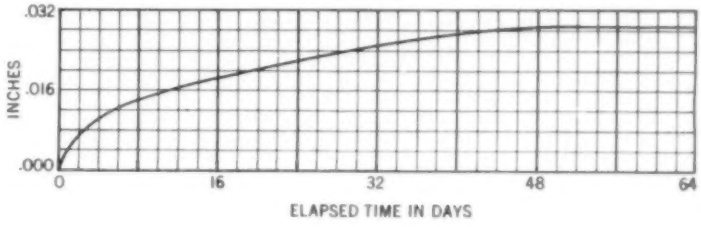
FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

NEWS FROM DOWN THE LINE!

Are all pipeline insulators as alike as two peas in a pod?

They're not alike, not in physical properties! When plastic insulators first became available for pipeline use, WmSON felt they were inferior to the steel and block types then available. We delayed our entry into the field until we could provide a plastic material to withstand field abuse and wear. We found that material in a high density polyethylene which could be injection molded to provide low cost insulators of the highest quality.

Our decision has proved sound. Breakage and excessive wear of glass fibre reinforced plastics, particularly in large sizes, has created a lack of confidence in plastics in general, but the M-2 Plastic THINsulator® has proved its stamina. Its high resistance to cold flow has been proved. Deflection test results: 1000 p.s.i. on each THINsulator runner for 64 days — total cumulative deflection only 0.029". Max. temp. during test, 105° F., min. temp., 75° F.



Its low coefficient of friction causes it to slide easily inside casing. The M-2 is completely resistant to impact fracture (4.0 ft. lbs./in. notched) and has successfully worked on 36" pipe, ½" wall, pulled in excess of 500 feet. We are convinced that it will perform as well or better than any other insulator on the market, including all known steel types. Other physical properties: *Dielectric strength* — (short time, ⅛" thickness) 500 volts per .001 inches (D149-55T); *Tensile strength* — 4400 p.s.i. at 20 in./min.; *Elongation* — 25% 20 in./min.; *Abrasion resistance* — Taber index 5.7.

The increased acceptance of the M-2 THINsulator has brought production to a level of real economy in injection molding. These cost savings are being reflected in new WmSON prices for 1961.

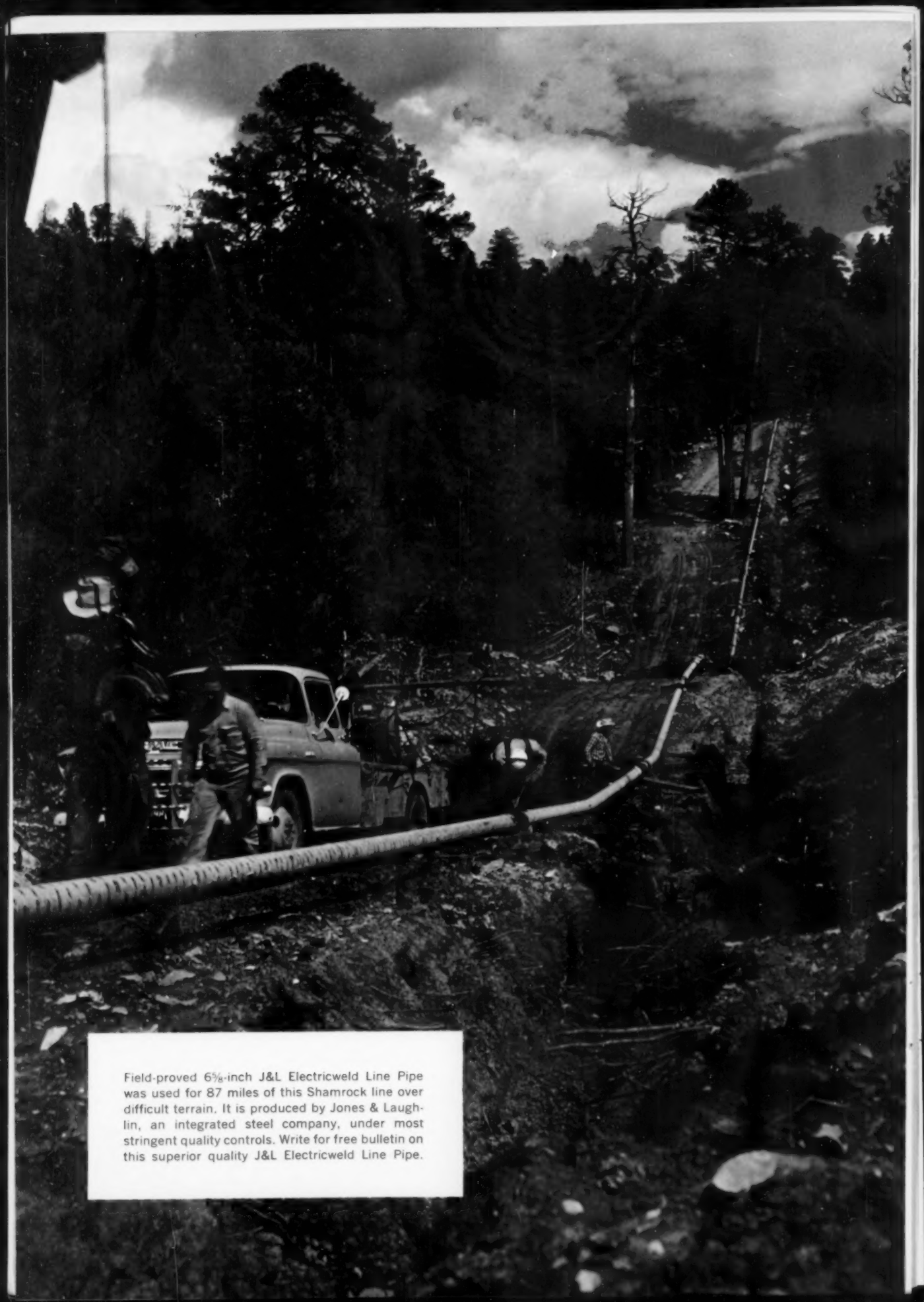
In planning '61 cased crossings, don't pay a premium for other insulators — use WmSON engineered M-2's and save!

T.D. Williamson, Inc.

P. O. BOX 40 • TULSA 2, OKLAHOMA

REPRESENTATIVES AROUND THE WORLD

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



Field-proved 6⅝-inch J&L Electricweld Line Pipe was used for 87 miles of this Shamrock line over difficult terrain. It is produced by Jones & Laughlin, an integrated steel company, under most stringent quality controls. Write for free bulletin on this superior quality J&L Electricweld Line Pipe.

New six-inch products line will be operated by Shamrock for its affiliate, West Emerald Pipe Line Corporation.

Welders on this Shamrock line reported that J&L Electricweld Line Pipe was uniformly round, easy to weld.

Pipe is produced under strict compliance with appropriate A.P.I. and A.S.T.M. specifications.

J&L

Contractors for the rugged section from Palma, N.M., to Albuquerque were Groninger & King, Pampa, Texas.

Pipe is A.P.I. Standard 5 LX, Grade X 42, 12.89 pounds per foot, with a .188 inch wall thickness.

"Superior weldability of J&L Electricweld Line Pipe was proved on this mountainous operation"

. . . reports pipe line contractor

Steep, mountainous terrain presented a real challenge to pipeliners working on this Shamrock Oil and Gas Corporation line from Amarillo to Albuquerque. Eighty-seven miles of 6⅝-inch J&L Electricweld Line Pipe were used in the rugged section from Palma, N.M., to Albuquerque. Performance proved conclusively that J&L Electricweld Line Pipe bends readily to contour, is easy to weld and is uniformly round. It is readily available from 6⅝ inches through 12¾ inches.

Jones & Laughlin Steel Corporation

PITTSBURGH, PENNSYLVANIA

J&L Electricweld Line Pipe is produced on one of the most modern mills in the world.

Hydrostatic test is one of a series of inspections and tests given every length of pipe.

This modern J&L ultra-sonic tester assures superior weld quality.

CONSTRUCTION COMING . . . in PIPELINING

Based on

• FPC • ICC • SEC • Owner Companies

Unusual Restrictions Mark B.C.'s Approval Of 500-Mile Crude Line

Westcoast Transmission Company, Ltd., has won permission to construct a 500-mile, 12-in. crude oil pipeline within British Columbia, but the B. C. government has heavily restricted the permit. According to details disclosed by Hon. Earle C. Westwood, minister of commercial transport:

Westcoast will be required to incorporate a B.C. subsidiary to build and operate the line.

The job must be started by May 1 and completed by November 1.

All materials must be purchased in the province from B.C. manufacturers, when feasible.

All labor must be hired within the province.

The rail line of the provincially-owned Pacific Great Eastern Railroad must be used to transport materials to construction sites. (The rail line parallels the proposed right-of-way except for the last 25 miles.)

A late bulletin announces that the company has been incorporated as Western Pacific Products & Crude Oil Pipelines, Ltd., and that two field parties — one working south from Fort St. John and the other north from Savona — have begun location work. Snowmobiles and four-wheel drive vehicles are being used.

The company must, on request by the provincial government at any time, extend the line to Vancouver. Such an extension would make the provincial refineries entirely integrated with a B.C. source of supply. At present all crude used in Vancouver comes from Alberta through the Trans Mountain pipeline.

Another unusual clause, believed unique in Canadian pipeline history, provides for the tariff to be charged by the company. The minister did not reveal the tariff schedule but said that it was designed to ensure a wellhead price of approximately $2.00 per bbl in the fields.

The line, with a designed capacity of 75,000 bbl per day, will begin at Taylor where it will take delivery of crude from northeastern fields via the new gathering system of Trans-Prairie Pipe Lines, Ltd., and extend to Kamloops where it will deliver crude into the Trans Mountain main line for shipment to Vancouver refineries.

Mountain Fuel Plans $10,000,000 Line For Newly Purchased Gas

Mountain Fuel Supply Company has contracted to buy the natural gas production of De Kalb Agricultural Association, Inc., in Uintah County, Utah, and plans to build a $10,000,000, 94-mile, 20-in. pipeline with Utah Natural Gas Company to move the gas to market.

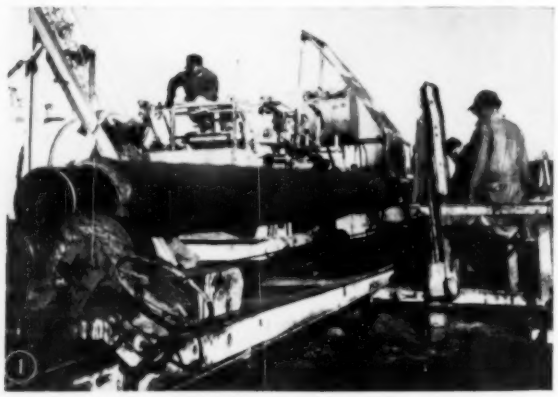
The pipeline would have a capacity of 100,000,000 cu ft of gas daily. Approximately 400 to 500 billion cu ft of reserves are involved in the contract with De Kalb.

As a part of the transaction, Mountain Fuel will purchase a 50 percent interest in the facilities of Utah Natural Gas Company, a subsidiary of El Paso Natural Gas Company, and then operate all of the facilities the two concerns would jointly own.

Long Gas Line Steps Up Montana-Dakota's Plans

Installation of a 106-mile natural gas pipeline between Minot and Bismarck, North Dakota, is one of the major projects revealed in an increased construction program announced by Montana-Dakota Utilities Company.

The proposed construction program spending of $12,800,000 in 1961 and over $12,000,000 in 1962 compares with $8,500,000 budgeted in 1960 and $6,310,000 spent in 1959.



Service Pipe Line Company expects to complete this month a mile-long crossing of the bed of the Keystone Reservoir on the Arkansas River in northeast Oklahoma. Williams Brothers Company is contractor on the job of lowering an existing 20-in. crude trunk line and adding a 16-in. and two 12-in. concrete-jacketed lines.

PHOTO 1. After conventional coating and wrapping is applied and tested, a 1½-in. coating of concrete is applied at a temporary pipe yard near the project. A 40-ft joint weighs about 6000 lb with concrete jacket.

PHOTO 2. The welded joint, after being X-ray inspected, receives coating and wrapping in place. Welded joints also are encased in concrete. At the extreme right of the two 12-in. and 20-in.—already in place—are sandpoints, water pipe and pump, used 24 hours a day to keep underground water from flooding the ditch during construction.

Algonquin Gas Transmission Co., Boston, Massachusetts, CP 61-220, filed February 28, 1961.

Description: Abbreviated application for authority to make additional maximum daily quantity sales of natural gas to existing customers through existing and additional facilities: an additional 11,461 Mcf on November 1, 1961, and an additional 14,147 Mcf on November 1, 1962.

Construction: November, 1961, service — an 8100-hp compressor station at Burrillville, Rhode Island, and a 5.6-mile, 8-in. pipeline loop from a terminal looping along existing 6 and 8-in. lateral to tap at Plymouth, Massachusetts. November, 1962, service — a 4000-hp compressor at existing Cromwell, Connecticut, station, and 5.8-mile, 20-in. loop on G-1 lateral extending from G-5 lateral takeoff to Providence near Attleboro, Massachusetts.

Cost: 8100-hp Burrillville station, $2,849,500, of which $741,500 is for structure; $25,000 for land; $130,000 for other structures and mains; $385,000 for major gas piping; $906,000 for compressor units; $38,000 for cooling water systems; $415,000 for other items; and $111,000 for contractor's fee. 4000-hp station, $1,100,000, of which $179,500 is for buildings and site improvements; $91,000 for major gas piping; $635,000 for main compressor units; $23,200 for cooling water systems; $95,000 for other items; and $42,000 for contractor's fee. Loops, $899,400, of which $321,293 is for pipe; $14,713 for valves; $47,715 for coating; $5917 for casing; $25,462 for other costs; $68,400 for right-of-way, survey, damages, mapping; $398,060 for installation; and $17,840 for contingencies.

Colorado-Wyoming Gas Co., Denver, Colorado, CP 61-209, filed February 10, 1961.

Construction: 1-mile, 4-in. line, plus replacement of 3-in. line serving General Chemical Company and Colorado Brick Company near Valmont, Boulder County, Colorado; and two metering stations, one to serve Flatiron Paving Company plant and the other to supply gas to Public Service Company of Colorado in the community of Valmont.

Cost: $30,500 total, which includes $13,000 for the 4-in. line, $9000 for the new 3-in. line; $6800 for the Flatiron Paving meter station; and $1700 for the Valmont meter station.

Hope Natural Gas Co., Clarksburg, West Virginia, CP 61-224, filed March 1, 1961.

FPC FILINGS

Recent Applications For Gas Line Construction

Construction: A system of gathering lines within Fink storage pool in two phases — Phase 1 to be completed by September 30, 1961, and Phase 2 by September 30, 1962.

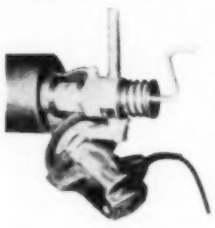
Cost: $320,000 for Phase 1 which includes — 3.19 miles of 8⅝-in. OD $35,700; 1.30 miles of 6⅝-in. OD, $9900; 1.65 miles of 4½-in. OD $9900; 75 ft of 12-in. conduit, $350; 50 ft of 10-in. conduit, $200; 150 ft of 8-in. conduit, $3000; valves, $16,100; oil separator, $14,000; fittings and drips, $9200; corrosion protection, $17,000; construction, $192,250. $470,000 for Phase 2 which includes— 2.31 miles of 8⅝-in. OD, $25,900; 3.01 miles of 6⅝-in. OD, $23,000; 6.80 miles of 4½-in. OD, $36,000; 75 ft of 12-in. conduit, $350; 150 ft of 10-in. conduit, $500; 400 ft of 8-in. conduit, $1000; freight, $4000; valves, $6300; oil separators, $22,000; measuring station, $13,000; fittings and drips, $13,600; corrosion protection, $28,100; construction, $295,750.

PATENT APPLIED FOR

STANDARD MACHINES

Fast, easy, accurate cutting and beveling of all sizes of pipe from 1½" through 36". Simple operation assures perfect cuts and bevels from moment torch is lighted.

PATENT NO. 2,869,293



BEVEL-LAND GRINDER

Smooths pipe cuts and accurately places the lands on bevels in a matter of seconds. Eliminates costly, time - consuming handwork.

H&M ACCESSORIES

Motorized Units
Flexible Shaft • Pipe Dollies
Boxes • Clamps

INSTALL PIPING SYSTEMS FASTER . . . EASIER, WITH H & M PIPE CUTTING AND BEVELING MACHINES

PATENT NO. 2,843,373

OUT-OF-ROUND

Makes cutting of irregular pipe easy, simple. Roller rides surface of pipe, insures even, accurate cuts. Fits all sizes of H&M Machines.

PATENT APPLIED FOR

SHAPE CUTTER

Cuts saddles, tees, els and other irregular designs. The lightweight extremely portable Shape Cutter fits all models of H&M Machines.

H&M TM Reg

PIPE BEVELING MACHINE CO.

311 E. Third St. LU 3-0241
TULSA, OKLAHOMA

El Paso Natural Gas Co., El Paso, Texas, CP 61-207, filed February 7, 1961.

Construction: Three 500-hp compressor units at Tex-Harvey field, with accessory equipment and necessary piping modifications to connect same with an existing 880-hp unit. Application also seeks to abandon Tex-Harvey field compressor station in Midland County, Texas, and 850-hp compressor unit leased from Pecos at same point; and seven 880-hp units to be placed in stock. Also, to abandon and place in stock one 25,000 Mcf dehydration plant at Tex-Harvey.

Cost: $910,713 for three 500-hp units, as follows: compressor units and related equipment, installed, $816,913; pipe, valves, and fittings, $9000; cylinders, $18,000; foundations, $1800; labor, $33,000; miscellaneous, $5000; other field costs, $7000; contractors fee, $11,000; general overhead, $4500; contingency, $4500. Book cost of facilities to be retired: $1,324,852.

Kansas-Nebraska Natural Gas Co., Inc., Hastings, Nebraska, CP 61-226, filed March 1, 1961.

Construction: Pipeline and other facilities to serve not more than six new agricultural processing plants within system, not more than three electric generation customers within system, and miscellaneous customers (exact location of facilities not yet determined).

Cost: Not to exceed total of $175,000.

CP 61-227, filed March 1, 1961.

Construction: Routine pipeline, measuring, and compressor station facilities (locations and nature unknown at this time).

Cost: $1,500,000 total, with individual projects limited to $500,000.

Southern Natural Gas Co., Birmingham, Alabama, CP 61-206, filed February 3, 1961.

Construction: 7.3-mile, 20-in. loop near Canton, Mississippi; 7.1-mile, 20-in. loop near Gwinville station, Jefferson Davis County, Mississippi; and meter station near Kosciusko, Mississippi.

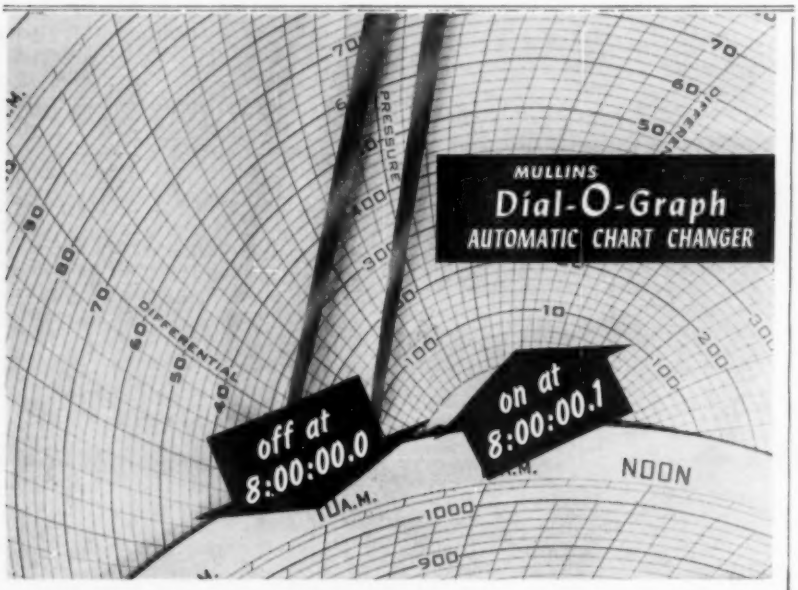
Cost: $1,500,260, which includes: line pipe materials, $585,720, and installations, $270,010; materials for crossings (including 550 ft of pipe), $5170, and installations, $2200; and $32,410 for rights-of-way, damages surveying, and mapping. General construction costs, including engineering and supervision, $18,040. The meter station totals $24,050 and includes: site, $1000; fence, $750; structures, $580; meter runs, $2660; headers and piping, $3700; instruments, $2280; valves, $4260; miscellaneous materials, $1000; installation, $3500; piping, $500; and engineering, $1200.

Tennessee-California Gas Transmission Co., Houston, Texas, CP 61-212, filed February 17, 1961.

Description: Application for disclaimer of jurisdiction, or alternately a certificate of convenience and necessity for construction and operation of facilities.

Construction: Approximately 105 miles of 26-in. from Humble Oil & Refining Company's King Ranch processing plant, Kleberg County, Texas, to U.S.-Mexican boundary near Reynosa, Mexico, to connect with new pipeline to be constructed and owned by **Petroleos Mexicanos,** which, in turn, would connect with new pipeline to be constructed by **California Gas Transmission Company** (see CP 61-172-3-4, reported in **PIPELINE ENGINEER,** February 1961).

Cost: $10,491,600 in total direct costs. Materials — pipe, $6,509,200; coating, $294,400; valves, drips, etc., $52,000; highway and railroad crossings (16 in. and 30 in. casing pipe), $33,100; river crossing, Rio Grande, $62,500; miscellaneous, $139,000. Installation — pipe, $2,154,800; valves, etc., $14,000; highway and railroad



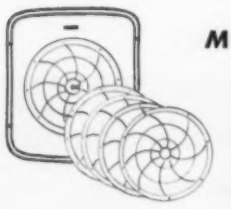
Elapsed time to change charts $\frac{1}{10}$-sec.!

The fastest, most efficient and dependable chart changer available . . . allows recorders to operate unattended . . . allows every recorder in your plant or system to be correlated to the same chart change time.

- Charts dial off instantly, no interruption of recording
- Adapts to any make, model, or type of recorder
- Field-proven . . . long used by most major gas companies
- Does not effect operation or appearance of recorder
- Charts handle, stack, and integrate as usual
- Current chart is always in view; completed charts are safely stored chronologically in chart catcher under recorder
- Capacity up to 50 charts in one loading

Write for illustrated literature with full details and prices. No obligation.

Dial-O-Graph is a simple, 3-piece attachment—Dial, Chart Plate, and Chart Drive (Mac-Nick)—that fits all recorders. Charts are slotted only in center margin . . . same pattern for all instruments, all change times. (Not shown is transparent guide plate and metal chart catcher for storage of completed charts.)



MULLINS
Dial-O-Graph
AUTOMATIC CHART CHANGER
MULLINS MFG. CO. • 3311 WEST DAVIS • DALLAS 11

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

crossings, $71,800; river crossing, $250,000. Right-of-way — $445,400. Preliminary survey — $104,400. Company inspection and engineering — $261,000.

Specifications: 105 miles of 26-in. OD by .375 pipe; 28 miles of 12¾-in. OD by .281; 18.1 miles of 6⅝-in. OD by .250; 22.9 miles of 4½-in. OD by .250.

Transcontinental Gas Pipe Line Corp., Houston, Texas, CP 61-221, filed February 28, 1961.

Construction: Budget-type abbreviated application for lateral and field facilities (not defined at this time) to enable purchase from independent producers in general area of existing system.

Cost: $1,500,000 total, with single project not to exceed $500,000.

Plans 350-mile LPG Line From New Kansas Plant

Northern Gas Products Company plans to construct a 350-mile, 8-in. pipeline to transport products from a natural gas liquids extraction plant now under construction at Bushton, Kansas, to the Des Moines, Iowa, area where it will connect to the Great Lakes Pipeline Company system.

The Northern Natural Gas Company subsidiary will construct terminals on its pipeline near Bushton, Kansas; Plattsmouth, Nebraska; and Des Moines, Iowa; and on the Great Lakes system near Mason City and Iowa City, Iowa; Rosemount, Minnesota; and Prophetstown, Illinois.

The pipeline — with an ultimate capacity of approximately 40,000 bbl per day — and the terminals will cost approximately $12,000,000.

FPC Aide Okays Lines To Up Gas To Florida

A plan of Houston Texas Gas & Oil Corporation and Coastal Transmission Corporation to construct more than 300 miles of pipelines to increase deliveries into Florida has received approval from a Federal Power Commission examiner.

Coastal and Houston Texas Gas & Oil must submit financing plans for commission approval before starting construction, it is reported.

The decision would permit construction amounting to $16,126,000 by Houston Texas Gas & Oil to increase its maximum day deliveries from 278,000,000 to 371,000,000 cu ft. It would allow Coastal to increase its capacity from 273,506,000 to 371,000,000 at an estimated cost of $7,275,000.

The examiner's decision authorizes two independent producers and one pipeline company (Southern Natural Gas Company) to sell gas to Coastal.

To Build $2,000,000 Plant, Gathering System

Construction of a pipeline gathering system connecting more than 100 wells in North Dakota's North Tioga and McGregor fields with a planned natural gas processing plant has been announced by Hunt Oil Company.

The $2,000,000 project is expected to be started this Spring.

Montana-Dakota Utilities Company said it has offered to purchase the gas processed at the plant, which also will produce butane, propane, sulfur, and other by-products.

To Start Jal Plant, Pipeline To Odessa

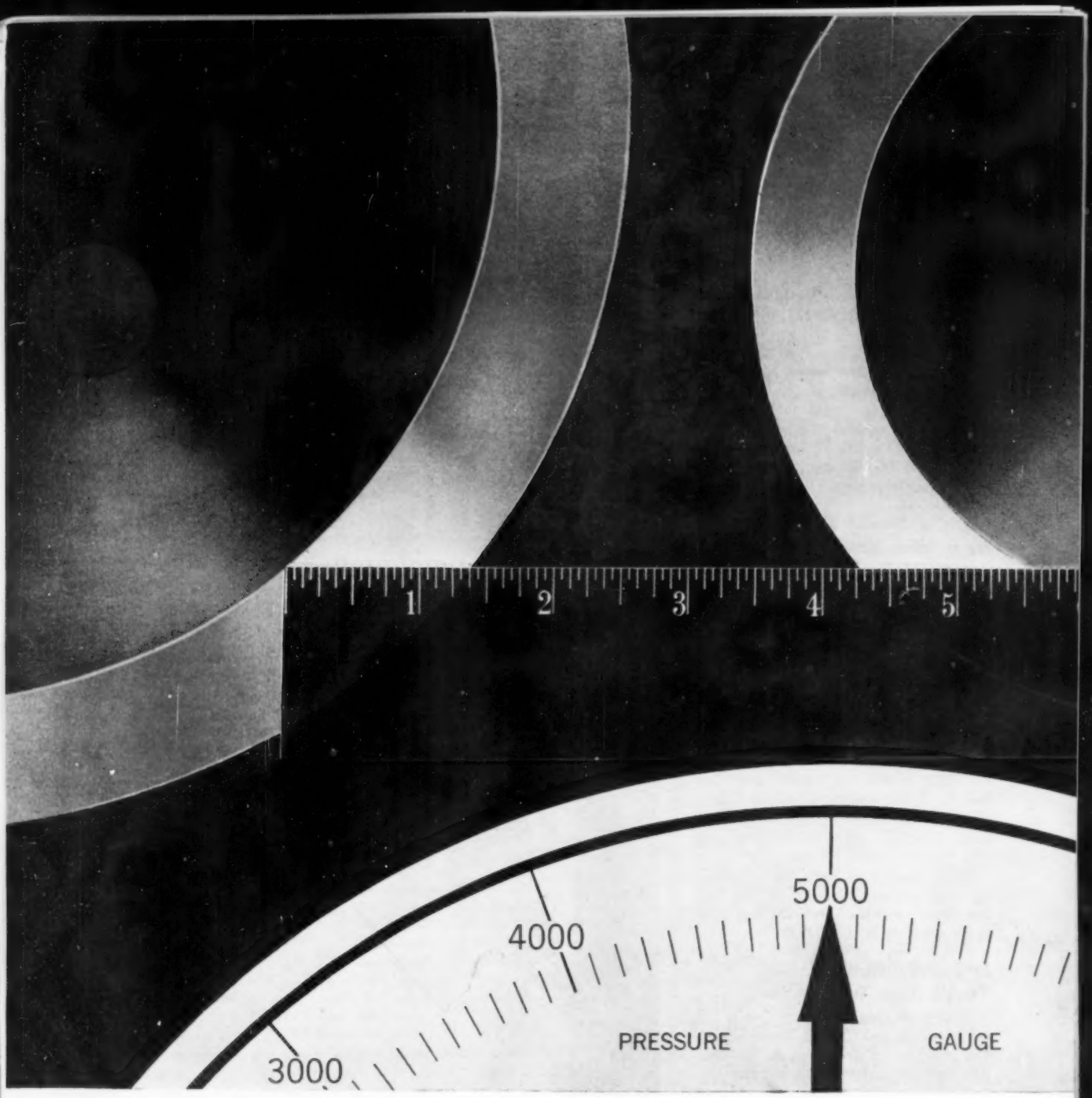
Construction of a 58-mile pipeline and ethane recovery unit near Jal, New Mexico, by El Paso Natural Gas Company is scheduled to start this Summer.

The recovery unit will process 650,000,000 cu ft of natural gas per day to provide raw material for the rapidly-expanding refining-petrochemical complex at Odessa, Texas.

The 6-in. pipeline will be built from Jal to Odessa to transmit the mixed stream of recovered products.

Arcco-Anubis
CONTINUOUS GAS
SAMPLER
FOR OBTAINING REPRESENTATIVE GAS SAMPLES TO DETERMINE CHEMICAL AND PHYSICAL PROPERTIES OF GAS.
For obtaining more accurate gas sampling, this proven Arcco-Anubis instrument is unexcelled. It replaces older, inadequate methods for spot sampling. This sampler will over a period of seven days accumulate at a constant rate a sample of gas to a final pressure at or near 130 psig from a sample source, the minimum pressure of which is not less than 150 psig.
Models for many other pressure ranges and sampling periods now are available. Send for Bulletin 112-R2.
MODEL 130-7
ARCCO
AVAILABLE FOR EARLY DELIVERY.
INSTRUMENT COMPANY, INC.
7144 EAST CONDOR STREET · LOS ANGELES 22, CALIF.
MANUFACTURERS OF PRECISION INSTRUMENTS

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



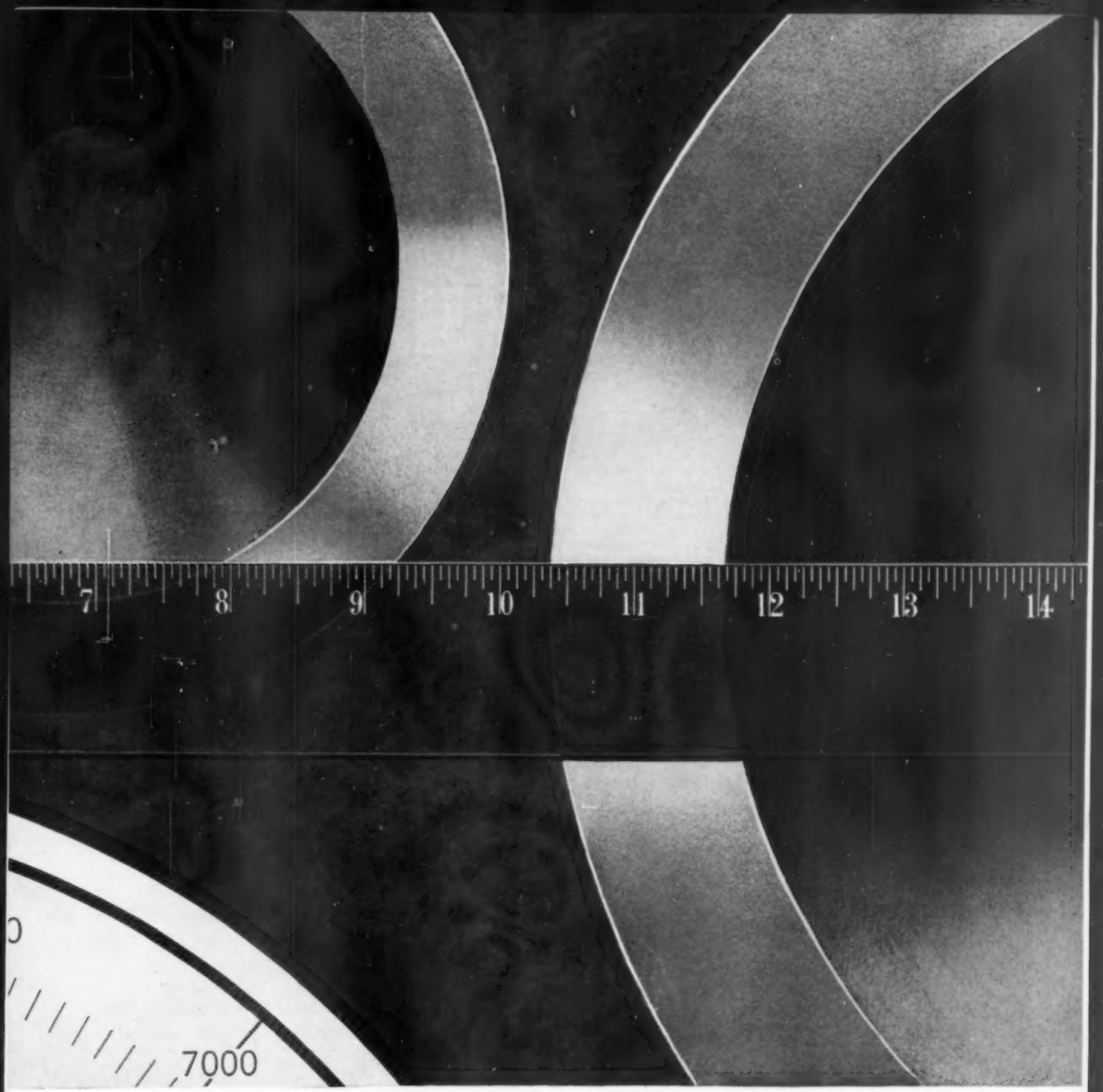
It takes cannon-barrel pipe to store gas at 5,000 psi

North of the Susquehanna River near Renovo, Pennsylvania, is a depleted gas reservoir known as Leidy Field. It has just been converted into an underground gas storage field. The field has a total of 85 wells and is roughly 13 miles long and 7 miles wide.

To store gas in this natural reservoir when completed requires an injection pressure of 5,000 psi at the wellhead. This storage field provides for a peak withdrawal of 800 million cubic feet each day and an average withdrawal of 400 million cubic feet per day during the winter season.

Seamless Steel Line Pipe was selected for this

This mark tells you a product is made of modern, dependable Steel.



project, because the high pressures demanded strong, reliable pipe with almost cannon-barrel thickness. Pipe walls ranged up to 1.312" in thickness in pipe size 6⅝-inch to 12¾-inch.

USS National Seamless Steel Line Pipe met these requirements. It is ideal for lines that handle gas, liquids and solids. It's available in a complete range of wall thicknesses, steel analyses, and in diameters up to 26 inches—USS National Electric-Weld Line Pipe up to 36 inches. Write for information on our products, services and facilities. National Tube Division, United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

USS and National are registered trademarks

National Tube Division of United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
United States Steel Export Company, New York

With the

PIPELINE CONTRACTORS

● **Alberta Consolidated Pipe Line Builders.**

Alberta Gas Trunk Line Company, Ltd. —113 miles of 36-in. from Priddis, Alberta, to a point near Rocky Mountain House, and 64 miles of 16-in. from the main line near Waterton Park gas field to the Montana border near Carway. Alberta Consolidated is a joint venture of Mannix Company, Ltd., and Piggott Construction, Ltd., both of Calgary, Banister Construction Company, Ltd., Edmonton, and Marine Pipeline and Dredging, Ltd., Vancouver.

● **Banister Construction Co. Ltd., 625 Northern Hardware Bldg., Edmonton, Alberta, Canada.**

Trans-Prairie Pipe Lines Ltd.—160-mile crude oil system in northeastern British Columbia, as follows: 40 miles of 4-in., Taylor to Dawson Creek; 30 miles of 6-in., Boundary Lake to Taylor; 75 miles of 8-in., Taylor to Milligan Creek field; 11 miles of 4-in., Milligan Creek to West Beaton field; 2 miles of 8-in., Taylor station to tank car loading rack; and 2 miles of 4-in., Taylor station to McMahon refinery. Crews are presently laying 8-in. pipe, under the supervision of Bill Bartlett.

● **O. R. Burden Construction Corp., Box 5216, Tulsa, Oklahoma.**

Alamo Gas Supply Co.—291 miles of 14 through 24-in. in southwest Texas to supply gas to San Antonio, Texas.

● **Canadian-Parkhill Pipe Stringing Ltd., 164 Eglinton Ave., E., Toronto, Ontario, Canada.**

Alberta Gas Trunk Line Co., Ltd.—under subcontract from Dutton-Williams Bros., 20 miles of 22-in. and 62 miles of 30-in. from Windfall to Lovett River; under subcontract from Majestic Contractors Ltd., 63 miles of 30-in. and 38 miles of 22-in. from Lovett River to Rocky Mt. House, and 113 miles of 36-in. from west of Calgary to the British Columbia border; and under subcontract from Piggott Construction Ltd., 64 miles of 16-in. from the southend lateral to the Montana border. Field office: Calgary. Curtis Williams is general superintendent, Wes Strangh is office manager.

● **Cape Construction Co., Box 423, Cape Girardeau, Missouri.**

Mississippi River Transmission Corp.—a 91-mile, 18-in. natural gas pipeline from near Johnsonville, Illinois, in Clay County, to St. Louis County (north of St. Louis, Missouri, where one field office is located), including dual 12-in. crossings of the Mississippi River. Other field offices: Breese and Salem, Illinois. Superintendents: R. C. Whitworth, G. L. Mims, and Trece Boyd.

● **D. Michael Curran & Co., Eklund Bldg., Great Falls, Montana.**

Northern Natural Gas Co.—65-mile, 16-in. in Minnesota. Superintendent: Don Foster. Field office: Duluth.

● **Dutton-Williams Brothers, Ltd., North Canadian Oil Building, Calgary, Canada.**

Alberta Gas Trunk Line Company, Ltd. —62 miles of 30-in. from West Cynthia to West Whitecourt, Alberta, and 20 miles of 22-in. lateral from this main line to the Whitecourt field. Harland Evens is project manager.

● **R. H. Fulton & Co., Box 1526, Lubbock, Texas.**

Continental Pipe Line Co.—550 miles of 2, 3, 4, 6, and 8-in. in Montana and Wyoming.

Natural Gas Pipeline Co. of America—33-mile, 10-in. between Normanna and Woodsboro, Texas. Field office: Beeville, under the management of Tom Davis. Clint Schell is superintendent.

handles all sizes of pipe—6 inches and up!

One C-R-C IMCO Pipe Beveler and cutting torch with a complete set of bands handles all sizes of pipe from 6 through 60 inches standard • Makes perfect, complete square cuts • cuts out-of-round pipe without additional attachments • flexible drive shaft permits safe operation • fast set-up—simple operation—easy to store or transport.

SERVING PIPELINERS SINCE 1923

For complete information write or call

CRC **CRUTCHER-ROLFS-CUMMINS, INC.**

Home Office: Houston, Texas, Box 2073, OVerland 6-4301.
Export Office: D. T. O'Conner, Inc., 500 Fifth Avenue, New York 36, N. Y., BRyant 9-2236
In Canada: Canadian Equipment Sales & Service Co., Ltd., 7310 99th St., Edmonton, Alberta, Canada

Cut pipeline anchoring costs about 85%

Get faster installation with less labor using the Chance Field Service Plan

Costs drop about 85% compared to counter weighting when you use Chance Screw Anchors and tie-down brackets. You can have the whole project engineered, supervised, and tested by Chance technicians. This cuts time and labor costs . . . makes certain the anchoring is adequate for every foot of pipeline.

Here's one job you can leave to *Chance!* We'll test the soil . . . recommend where anchors should be used, sizes needed, proper anchoring depth. We'll also supply special installation equipment and the services of an installation supervisor for a reasonable fee. Call or write for complete information.

Petroleum Equipment Engineering and Services Division of

A. B. CHANCE CO. **Houston 2, Texas**
1311 Polk Ave. Phone: CApital 8-2777

COS1-4 **INTERNATIONAL DIVISION • CENTRALIA, MO., U. S. A.**

H&L Teeth that really dig!

STAY SHARP-CUT MAINTENANCE COSTS GIVE MILES AND MILES MORE TRENCH

PAT. NO. 2807105

H&L POINTS are carefully formulated of High Alloy Nickel Steel, hammer forged for greater density and uniform grain flow.

Then heat treated in electronically controlled hydrogen atmosphere furnaces, creating extreme hardness and resistance to high impact.

H&L has a point for every type of digging job, and for every make and model of digging equipment.

H&L

SEE YOUR H&L DEALER

TOOTH COMPANY

1540 SOUTH GREENWOOD AVENUE
MONTEBELLO, CALIFORNIA

SPECIALISTS SPECIALIZING IN THE MANUFACTURE OF BETTER DIGGING POINTS FOR OVER 30 YEARS

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

"DOES WORK OF TWO DITCHERS HANDLING ALL 3 OF MY JOBS"

Pipeliner Pete Gallatin calls Barber-Greene Model 774 Ditcher "most modern, advanced construction machine... completely new ditching concept"

Pipeline construction company president Pete Gallatin knows increasing ditching production by 100% is as easy as changing machines—stepping up to a Model 774 Barber-Greene with 7-ft. wheel —the industry's biggest buy because it outdigs and costs 50% less than any other 7-ft. ditcher.

He reports: "My company handles virtually every phase of pipelining and for five years I used other ditchers. But this Model 774 Barber-Greene opened my eyes from the start—does the work of two same-size ditchers and trenches so fast I can keep all three of my jobs in Michigan and Illinois moving by shuttling it back and forth. It not only gives me 100% more production, but it excavates boulders and rocks far easier than other ditchers I owned. For my money, it's the most modern, advanced construction machine on the market with a completely new concept of digging—not just an alteration to existing equipment."

Exclusive dual-range Hydra-Crowd transmission makes the big difference. Operators dial *instantly* the maximum crowding speed for any ground condition, or reverse *instantly*, too. They select from *infinitely variable* crowding speeds *independent* of wheel and conveyor drive. No four-operation gear shifting. No guessing about gear ranges. No stopping to change speeds.

Check with your Barber-Greene Distributor and see why Hydra-Crowd and these additional features are found exclusively in the only modern ditcher line: Flexible drawbar between chassis and boom; all-hydraulic spoil conveyor independent of wheel speeds; hydraulic controls for greater line-and-grade-holding accuracy; crawler adjusted 10 times faster than those on ordinary ditchers; and automatic electric overload protection.

Barber-Greene 774 has ditched more than 50 miles for Gallatin by being shuttled between Michigan and two Illinois job sites.

Gallatin's 774 is shown digging trench for gathering lines for Marathon Pipeline Co., near Mosherville, Michigan.

Model 772 (shown) is your best buy for the general utility range—cutting widths from 10-24" and to 5' 6" deep. Model 773 varies only in its wider track gauge.

Manufacturer of the only modern ditcher line

Representatives in Principal Cities of the World

Barber-Greene BG

Main Office and Plant AURORA, ILLINOIS, U. S. A.
Other Plants: DeKalb, Milwaukee, Detroit, Canada, England, Brazil, Australia

CONVEYORS • LOADERS • DITCHERS • ASPHALT PAVING EQUIPMENT

PIPELINE CONTRACTORS

● **H & K Construction Co., S. San Patricio, Sinton, Texas.**

Seadrift Pipeline Co. — 80-mile dual 6-in. LPG line as joint venture with Roy Vickers Lease Service starting at Markham and ending at Baytown, Texas.

● **Hall Construction Co., 1105 N. Carlton, Liberal, Kansas.**

Panhandle Eastern Pipe Line Co.—a 330-mile, 4 through 12-in. gathering system in western Kansas. Supervising are Mike Bell and M. E. Banning.

● **Houston Contracting Co., 2807 Buffalo Speedway, Houston 6, Texas.**

Trancontinental Gas Pipe Line Corp.—dual 30-in. crossing of the Mississippi River near St. Francisville, Louisiana.

Trans-Southern Pipeline Corp.—dual 10-in. crossing of the Mississippi River near St. Francisville, Louisiana, where field office is located under L. F. Redfearn. Superintendent: L. A. Young.

Tennessee Gas Pipeline Co. — 7 miles of 8-in. below Houma, Louisiana, where field office is located under Sam Harrison. R. E. Thornton is superintendent.

● **Majestic Contractors Ltd., 49 Jackes Ave., Toronto 7, Ontario, Canada.**

Alberta Gas Trunk Line Co., Ltd.—113 miles of 36-in. from west of Calgary to the British Columbia border; and 63 miles of 30-in. and 38 miles of 22-in. from Lovett River to Rocky Mt. House to Cynthia, Alberta. Project office for the 36-in. line is in Blairmore, Alberta, with R. L. Leonard as superintendent. Rocky Mountain House, Alberta, is site of project office for 22 and 30-in. lines and K. B. Killingsworth is superintendent.

● **J. P. Neill and Company, Meadows Building, Dallas, Texas.**

Pacific Gas Transmission Company—468 miles of 36-in. from California-Oregon boundary to Rosalia, Washington, as joint venture with Western Pipeline, Inc., Austin, Texas. Hermiston, Oregon, is field office now for a 153-mile, 36-in. segment from Hermiston to Rosalia, Washington. Jack Hays is superintendent, and Glen Goyne is office manager.

● **Piggott Construction Ltd. (Pipeline Div.), 608 Renfrew, Rideau Towers, Calgary, Alberta, Canada.**

Hudson Bay Oil and Gas Co. — 26 miles of 14-in. from Pine Creek to Windfall, Alberta. Superintendent: M. L. Boyd. Office manager: T. E. Dougherty.

● **H. C. Price Co., Price Tower, Bartlesville, Oklahoma.**

Pacific Gas & Electric Co.—291 miles of 36-in. to the Oregon border from the San Francisco Bay area. Superintendent: R. L. Ezell. Office Manager: Bob Walker at Tulelake.

Pacific Gas Transmission Company—146 miles of 36-in. from Rosalia, Washington, to the Idaho-British Columbia border. Superintendent: G. A. Reutzel. Office manager: E. Dickson at Bonners Ferry, Idaho.

● **Price-Poole of Canada, Ltd., Box 969, Cranbrook, B. C., Canada.**

Alberta Natural Gas Company — 107 miles of 36-in. from Crowsnest Pass to the Idaho boundary at Kingsgate-Eastport. Joint venture of H. C. Price Company of Canada, Ltd., Calgary, and Poole Construction Company, Ltd., Edmonton. C. E. Shivel is superintendent, and L. D. Burden is office manager at Cranbrook, B. C.

"LATE LIGHTS"
To Serve You . . .
Seeking . . . and finding, better communication systems is part of our life at USI. Sure in the knowledge that one of our systems can serve you best, we invite your next bid. Better still, why not call us today!
TYPE 50A PX
TYPE 50B PX
UNITED STATES INSTRUMENT CORP., CHARLOTTESVILLE, VIRGINIA

● **River Construction Corp., Box 9127, Ft. Worth 7, Texas.**

Pacific Gas Transmission Co.—36-in. single-line crossings of the Kootenai and Pend Oreille rivers near Bonners Ferry and Sandpoint, Idaho, respectively, sites of headquarters. H. H. Mehail is superintendent.

● **Sheehan Pipe Line Construction Co., 514 National Bank of Tulsa Bldg., Tulsa, Oklahoma.**

Transwestern Pipeline Co.—has underway an additional 100 miles on the 4, 6, 8, 10, and 12-in. gathering system in Oklahoma, Texas, and New Mexico.

● **Stanley-Bledsoe Corp., 612 Daniel Bldg., Tulsa 3, Oklahoma.**

Pacific Gas Transmission Co.—double-jointing and yard-treating 466 miles of 36-in. pipe in three schedules in Klamath, Jefferson, Umatilla, and Gilliam counties, Oregon, and Walla Walla and Whitman counties, Washington. Superintendent: W. D. Smith, Jr.

● **Turriff-Burden, Ltd., Turriff Bldg., Great West Rd., Brentford, Middlesex, England.**

Iraq Petroleum Co. Ltd.—315 miles of 30 and 32-in. pipeline from Kirkuk to the Syrian border, connecting Rumaila and Fao. M. T. Wilhite is project manager in Baghdad, Iraq. Field construction superintendent is G. E. Beaver, assistant manager is P. A. McCormack, and office manager is Brian H. Lusk.

● **Ray Vickers Lease Service, Box 648, Robstown, Texas.**

Seadrift Pipeline Co.—80-mile dual 6-in. LPG line as joint venture with H & K Construction Company starting at Markham and ending at Baytown, Texas.

● **Western Pipeline, Inc., 311 East 11th Street, Austin, Texas.**

Pacific Gas Transmission Company—468 miles of 36-in. from California-Oregon boundary to Rosalia, Washington, as joint venture with J. P. Neill and Company, Inc., Dallas, Texas. J. C. Oliver is project manager. Johnnie Wells is superintendent on a 150-mile segment between Malin and Bend, Oregon; and Ervin Simpson is superintendent on 150 miles between Bend and north of Ione, Oregon.

● **Williams Bros. Co., National Bank of Tulsa Bldg., Tulsa, Oklahoma.**

National Iranian Oil Co.—a 516 mile, 8-in. petroleum products line in Iran from Rey, near Tehran, northeast to Meshed.

Calnev Pipe Line Company—240 miles of 8-in. products line from Las Vegas, Nevada, to Colton, California. Field office at Las Vegas, M. O. Thompson, superintendent.

Bataafse Petroleum Maatschappij, N.V.—a 157-mile, 20-in. pipeline in Indonesia. Field office: Balikpapan. Superintendent: J. Childress.

Niederoesterreichische Gasvertriebs, AG (NIOGAS)—47 miles of 8 through 10-in. in Austria. Headquarters: Herzogenberg. Superintendent: W. Tierney.

Service Pipe Line Co.—a 3-line Arkansas River crossing in Pawnee and Osage counties, Oklahoma (11,000 ft of 12-in. and 5500 ft of 6-in.). Jim Martindale is superintendent, with headquarters located at Osage, Oklahoma.

● **H. B. Zachry Co., Box 10188, San Antonio 21, Texas.**

Natural Gas Pipeline Co. of America—55 miles of 20-in. between Falfurrias and Hebbronville, Texas, where field office is located. Superintendent: Ray Shields.

United Gas Pipe Line Co.—a 22-mile, 24-in. between Harris and Ft. Bend counties, Texas.

News of

PIPELINE SUPPLIERS

Pipeline valves manufactured by W-K-M division of **ACF Industries** roll from the division's Houston, Texas, plant to the port of Houston for shipment to the Middle East where they will be used on a 600-mile crude oil line stretching from Kirkuk, Iraq, to Tripoli, Lebanon. At the send-off for the 140-ton shipment are: Marvin Hurley, executive vice president of the Houston Chamber of Commerce; J. S. Downs, division president; and B. J. Gross, division vice president for marketing.

Fluid dynamics department is the new name for **Allis-Chalmers** pump and compressor department. E. F. Greiwe is department manager.

New president of the Power Crane and Shovel Association is Lewis C. Black, vice president in charge of sales for **Bucyrus-Erie Company.**

April appearance dates for the microwave and carrier communication system engineering symposium sponsored by the Texas Division of **Collins Radio Company** are as follows: Denver, Colorado, April 10; and Chicago, Illinois, April 24.

A French pipeline construction firm representative visited **Crose-Perrault Equipment Corporation** in Tulsa, Oklahoma, recently to finalize purchase of pipe double jointing equipment for a large pipeline project in Algeria. He is Bernard Raffaelli, engineer with Socoman, subsidiary of Compagnie de Pont a Mousson, pictured at left with: John Manley, Crose-Perrault export sales manager; Francois Montignot, engineer specialist for Poulet Mousson; and Charles Andre, public relations manager for the French Chamber of Commerce in the U. S.

Grenoble, France, is the site of the new manufacturing plant of **Caterpillar France S. A.**

Acquisition of the materials, inventory, and patents of the Sooner Boomer Manufacturing Division of Oklahoma City, Oklahoma, by **Midwestern Manufacturing Company,** Tulsa manufacturer of hydraulic sideboom pipelaying equipment, has been announced by Midwestern president, Armon H. Bost. Hubert Gragg, former owner of Sooner Boomer, which has specialized in producing sidebooms for rubber-tired tractors for more than four years, will act as a dealer for both Sooner Boomer and Midwestern's "Little Boomer" sidebooms. Midwestern is expanding its line to include sideboom equipment to be mounted on 1 to 3 cu yd loaders.

Standard Pipeprotection, Inc., has been licensed by Republic Steel Corporation to use Republic's X-Tru-Coat process for coating steel pipe and plans a second plant expected to be operating about May or June, at Alton, Illinois.

Hill Hubbell Company announces that completely modernized plants will be ready to apply X-Tru-Coat in the second quarter of 1961. Located in Youngstown and Lorain, Ohio, and Hammond, Indiana, these plants will initially coat sizes ranging from ¾ to 5 9/16 in. OD.

The Republic Creosoting Company has merged with its wholly-owned subsidiaries, Reilly Tar & Chemical Corporation and Char Products Company. The merged company is now **Reilly Tar & Chemical Corporation.**

FLEET-LINE

WELDING FITTINGS

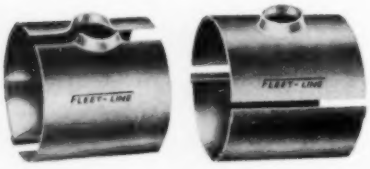
•

LITERATURE BY AIR MAIL... ...ask for it now.

REDUCERS: Concentric and eccentric. Nominal pipe sizes 1" to 30", ASA B16.9, ASTM A234. Schedules 10 to 160, stainless steel, and other alloys. Special lengths and sizes.

SADDLES: Conventional, and for pressure vessel heads. Nozzle sizes from ¼" to 24". Fleet-Line saddles weld neatly into place in much less time, and with much less welding rod.

Full encirclement saddles.



REDUCING TEES, Forged Steel Manifold Type.

Dealers and Stocking Distributors throughout the United States and Canada.

All orders acknowledged by air mail or long distance telephone and filled at once.

STEEL FORGINGS, Inc.

P. O. Box 276A • Shreveport, La.

News of

PIPELINERS

▸ **First full-term president** of the newly-formed North Texas chapter of the American Right-of-Way Association is **Purvy L. Stone,** Lone Star Gas Company's superintendent of right-of-way and claim. **George Willis,** Lone Star right-of-way agent, is secretary-treasurer of the chapter.

▸ **An engineer** in Texas Eastern Transmission Corporation's plans and research division, **Howard E. Kirby, Jr.,** has been promoted to assistant supervisor of that division.

▸ **Sinclair Pipe Line Company** has promoted **William W. Shaw** to manager of the right-of-way department to succeed **Fred A. Crane** who has retired. Succeeding Shaw in his former position as assistant manager is **Hamilton A. Cade,** formerly right-of-way supervisor. **John F. Stichman** has been promoted to assistant comptroller and is succeeded in his former position as assistant chief accountant by **L. L. Fare,** formerly accounting department supervisor.

▸ **In major changes** in managerial personnel for operations of Pipe Line Technologists, Inc., **Thomas M. Thawley** has been assigned to The Hague, Netherlands, as manager of European operations to replace **Richard S. Barfield** who is returning to the Houston, Texas, headquarters as supervising engineer-design.

C. H. Ward

▸ **Charles H. Ward has joined Northern Natural Gas Company** as director of its engineering design department. He was formerly with Williams Brothers Company as project engineer on pipeline design and construction in the Middle East, South America, and the U. S.—most recently on the Mid-America LPG line. In his Northern Natural post, he will be responsible for design of plant and pipeline facilities.

▸ **S. A. Hallberg,** who has been managing the Chicago division of American Oil Company's 2400-mile products pipeline system, has been appointed general superintendent-product movement. He will direct product movement by ocean and lake tankers and by barge, as well as by company-owned and common carrier pipeline. He joined Standard Oil Company (Indiana) in 1946 and has held a number of pipeline positions in Chicago and Minneapolis. In his new post, he succeeds **J. R. Polston** who moves to a new post with Standard Oil.

▸ **Now superintendent** of Buckeye Pipe Line Company's Cleveland trunk line division is **J. R. Anderson,** who also continues as superintendent of the company's gathering lines. **Richard Garnjost** was appointed assistant superintendent of these divisions.

DITCH WITCH TRENCHER

Produces Lowest Cost Trench for TRANSMISSION LINES

This compact, but powerful Ditch Witch offers 4-wheel drive, 4-speed transmission, adjustable boom, many features! Digs trench up to 16" wide, 6' deep; digs even in frost or rocky conditions.

30 HP Model K-1 shown here

OTHER SIZE DITCH WITCH, 7 TO 12 HP, DIG UP TO 12" WIDE & UP TO 5' DEEP

Manufactured by the CHARLES Machine Works, Inc.

674 BIRCH ST. • PERRY, OKLAHOMA • CALL COLLECT: FE 6-4404

It's New | Pipeline Equipment

All-In-One Dozer Blade

Straight, angle, forward "V," reverse "V," tilt, or any combination of these blade positions is possible with "Varidozer" in a matter of seconds, under full load or empty, while tractor is moving in either direction. The vertical hinge in the center permits each section to move independently to any position from full 25 deg forward to full 25 deg to the rear. An inside-mounted push frame supports the "Varidozer." Push arms contain two fully-protected 6-in. cylinders, while two 5-in. cylinders allow the entire blade to be tipped 10 deg forward or back and tilted up to 56 in. to either side. Operator selects blade position from four hydraulic levers mounted beside tractor seat. The 6000-lb model 6H was designed for use on Caterpillar D6 tractors, with others to fit larger tractors planned for the future. *Ulrich Manufacturing Co.*

Circle number (81) on reply card.

New In Plugging, Evacuating

New pipeline plugging pigs for any size line have been announced for plugging and evacuating pipelines for replacement or repair and for hydrostatic testing of existing as well as new lines. This new pipeline plugging pig method, the manufacturer points out, minimizes down time (and there is no down time if by-pass is extended beyond first plugging pig). Other advantages: virtually no loss of line contents, no need to drain line, no heavy equipment needed on job site, no large fittings left on line. Line is purged with an inert substance before cut is made. *Pipeline Plugging Pig, Inc.*

Circle number (82) on reply card.

NEW AND EXCLUSIVE with McCord Model 55 Lubricator

SAFE-LEVEL SIGHT FEED

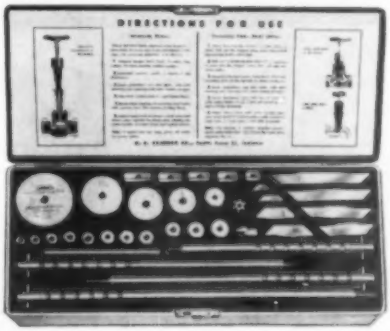
That's right! The finest lubricator on the market today has been refined to give you even *more* for your money. Now, the McCord Model 55 Lubricator comes equipped with new, exclusive Safe-Level Sight Feed with these outstanding benefits for you . . . safe, sure warning of malfunction . . . quicker priming . . . better feed regulation . . . extreme accuracy . . . improved reliability. IMPORTANT: Safe-Level Sight Feed can also be added to existing Model 55 Lubricators.

For COMPLETE details on this important new development write today to:

McCORD CORPORATION

Lubricator Division • Detroit 11, Michigan

RESEATS VALVES and BIBBS QUICKLY ECONOMICALLY



Easily pays for itself on the first two jobs!

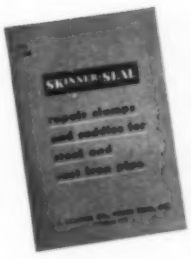
Reseats flat and tapered-seat globe or angle valves—all bibbs and faucets—in place, quickly and accurately. The saving, over tearing out and renewing leaky valves and fixtures, is tremendous.

Cutters operating under screw feed, leave worn, scored seats glass-smooth, level, absolutely accurate and tight.

A guide pilot centers each cutter; a tapered cone centers each spindle. Perfect alignment is inevitable. Cutters guaranteed. Write for literature!

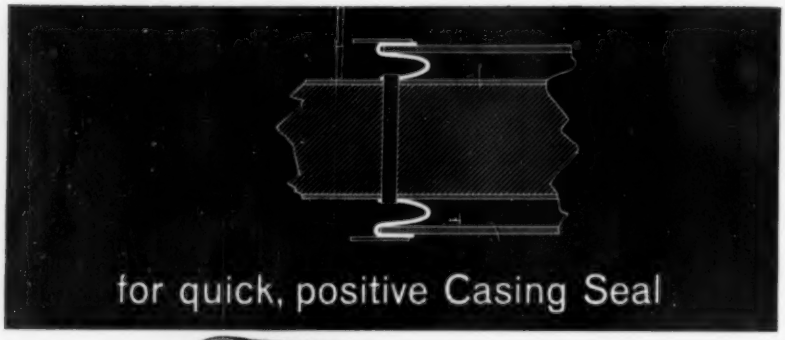
2" for ¼" to 2" valves and ¼" to ¾" bibbs
List price $59.85

3" for ¼" to 3" valves and ¼" to ¾" bibbs
List price $79.50

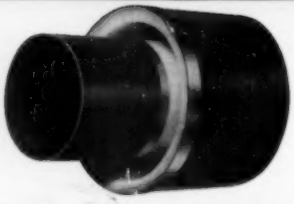


FREE **catalog showing our pipe repair clamps, saddles, and reseating tools**

M. B. SKINNER CO.
SOUTH BEND 21, INDIANA



for quick, positive Casing Seal



NO EDGE CUTTING,
BACK-FILL DAMAGE OR
ROCK SHIELDS

more economical
simple, fast installation
compensates for pressure
from either direction

USE **GREENHEAD** CASING SEALS

3800 West Alabama, Houston 27, Texas, Phone: MOhawk 7-3356.

The most effective PIPE LOCATOR in the world

FIELD PROVED

the award winning

"Signalmaster"

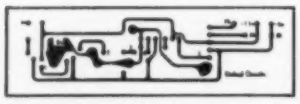
TRANSISTORIZED

PIPE LOCATOR

MODEL TR-1A

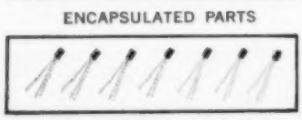
Utility and Construction Companies, Municipalities are unanimous in agreeing that MODEL TR-1A has proved most effective for locating mains, services, valves, conduit, high voltage lines, telephone cables. Easily separates parallel lines and can be used to trace non-metallic pipe lines. Complete piping systems traced out.

SPECIFICATIONS: Size of cases when clamped together: 9½" x 12½" x 5½" • Size of transmitter and receiver boxes, each: 9½" x 12½" x 2¾" • **Operating weight,** transmitter: 4½ lbs. • **Operating weight,** receiver: 4¾ lbs. • **Circuit:** Transmitter—one transistor, Receiver—six transistors • **Batteries:** Transmitter—4 size C flashlight cells, Receiver—4 size C flashlight cells • **Switching:** a. Automatic power switching for all "on-handle" operations. b. Automatic "turn-off" when set is not being used.



ETCHED CIRCUITRY

ENCAPSULATED PARTS

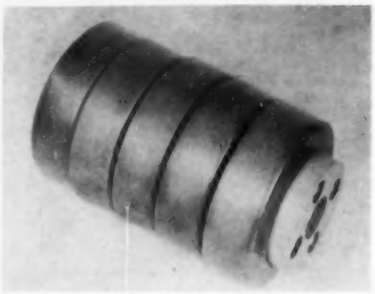


SEVEN TRANSISTORS

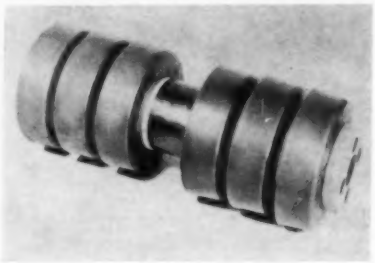
The GOLDAK Company, Inc.
Leading Electronic Manufacturers
1933

1540 W. Glenoaks Blvd.
Glendale 1, California

Lightweight, Plastic Pigs . . .



For Separation, Displacement



New lightweight, plastic pigs have been introduced for separation of dissimilar fluids, displacement of gases with liquids and liquids with gases, removal of condensates from gas lines, and other "squeegee" uses. Light weight provides minimum cup loading, reduces friction, results in steady movement. Multiple sealing surfaces are said to keep constant seal under typical pipeline conditions—past side openings and minor obstructions. Designated SBN-5PL and SB-6PL, they are available in sizes 4 through 14-in., require no inflation or deflation, no special handling, and no skill in assembly or disassembly. *T. D. Williamson, Inc.*

Circle number (83) on reply card.

Fully Convertible "Quick-Ways"

Ranging from ⅜ to ½ cu yd capacity is a new series of crawler-mounted "Quick-Ways"—machines which can be converted in minutes to cranes, trench hoes, shovels, clamshells, draglines, or pile drivers. Features: tractor-type undercarriage, independent swing and travel, two speed traction forward and reverse, and double spring positioned shock absorbing idler sprockets. All lubrication points of crawler underframe are lubricated from a single position. *"Quick-Way" Truck Shovel Co.*

Circle number (84) on reply card.

Modified Angle Compressor

A new modified version of Clark Model TLA gas-engine-driven compressors will be built in five, six, eight, and ten power cylinder models rated at 1500, 1800, 2400, and 3000 bhp respectively. Therefore, the TBA—with 17-in. by 17-in. bore and stroke—will supplement the TLA in intermediate horsepower steps. The TBA operating characteristics are the same as the TLA in all respects, except that it is a shorter stroke machine. Turbocharger is jet air started, fully automatic and completely self-sustaining at normal operating speeds. This constant pressure type turbocharger system, coupled with new automatic ignition timing control, makes the TBA suitable for variable speed—variable load applications. *Clark Bros. Co., One of the Dresser Industries.*

Circle number (85) on reply card.

It's New | PIPELINE LITERATURE

Pumping Manual giving hydraulic tables and engineering information is available. Following several pages of general information, there are tables on cost of operating pumps, tank capacities, friction losses, steel pipe and equalizing pipes, effective fire streams, viscosity of liquids, materials for pumping various liquids, etc. *Pacific Pumping Co.*

Circle number (90) on reply card.

Specific Program for evaluating gear lubricants highlights a new edition of "Almasol Gear and Bearing Lubricants." A second brochure is available — "Facts About Almasol." *Lubrication Engineers, Inc.*

Circle number (91) on reply card.

For Gas Gathering, Repressuring, and booster service, a new line of medium speed, balanced opposed compressors have been introduced. Described in an illustrated 10-pager, the W-62 (2-cylinder) and W-64 (4-cylinder) are engineered for direct drive with White "Superior" natural gas engines. Matched engine-compressor units are available from 200 to 1000 bhp operating at 600 to 900 rpm with the compressor using a 6-in. stroke. *White Diesel Engine Div., The White Motor Co.*

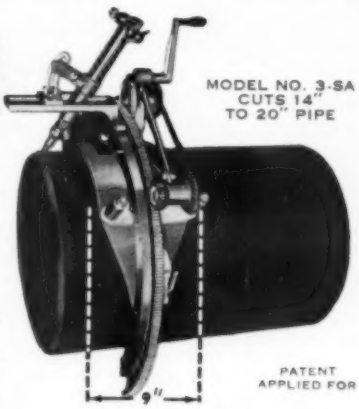
Circle number (92) on reply card

A Mastic Protective Coating, Pioneer #1008 Vapor Seal—a blend of asphalts, petroleum resins, plasticizers, asbestos, mica, and solvents—is described in a new 4-pager which includes data on its physical properties, chart for calculating number of gallons needed to provide specific film thicknesses over unit coverage areas, application procedures, insulation values, and instructions for incorporating colored granules. *Witco Chemical Co., Inc.* Circle number (93) on reply card.

Maintenance Men! A heavy-duty detergent . . . Oakite RR Cleaner which may be used in cleaning tank or steam cleaning operations for removing burned-on oil and lubricants, welding flux, caked dirt and grease, oil and carbon combinations, and similar stubborn soils . . . is described in a new service bulletin. *Oakite Products, Inc.*

Circle number (94) on reply card

NEW!



FEATURING BALANCED RING GEAR-SADDLE ASSEMBLY !

LIGHTER WEIGHT! EASIER TO USE !

MOUNTS AND CUTS ON SHORT LENGTHS OF PIPE!

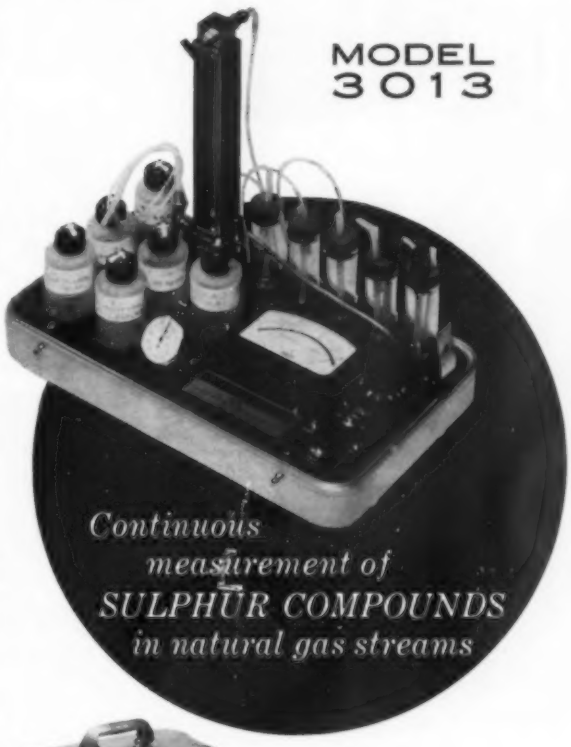
- It's extremely lightweight.
- It's easier to handle and operate with the new balanced design.
- Requires only ½ the storage space of competitive pipe beveling machines.
- Can be operated on shorter lengths of pipe for seating the machine and cutting, making it more versatile.
- More rugged . . . this new design produces a more stable ring gear assembly, which is less likely to spring or warp.
- Retains extreme accuracy of cuts, which all Mathey Pipe Beveling Machines are noted for.
- Available in all sizes, from No. 1 to No. 5 machines.

Call or Write for Further Information or Demonstration.

C.A. Mathey MACHINE WORKS, INC.
212 S. Frankfort — Tulsa, Okla. • Box 1159 • LUther 7-3311

AUSTIN GAS TITRATOR

MODEL 3013



Compact, Portable, Rapid

Fast, reliable, compact, easily maintained. Use in field or laboratory. Quick analyses by non-technical personnel. Ideal for odorant control analysis in distribution systems, process control analysis in plant streams, and corrosion control in critical facilities such as copper service lines.

SENSITIVITY: 0.01 grains H_2S per 100 cu. ft.

RANGE: 0 to 2 and 0 to 10 grains H_2S per 100 cu. ft.

ASI

For additional information write: INSTRUMENT DIVISION

AMERICAN SYSTEMS *Incorporated*

1625 East 126th Street, Hawthorne, California

An affiliate of Schlumberger Well Surveying Corporation

Rugged transistorized construction practically eliminates maintenance costs... extends battery life to a year or more. Pinpoint accuracy, greatest depth penetration make the M-scope first choice in the field! Only $189.50

Send for FREE catalog

SINCE 1932
Fisher RESEARCH LAB., INC.

DEPT. CM-1, PALO ALTO, CALIF.

Cleaner-Snubber Combination . . . type SDF . . . designed to be used in place of separate air intake filters and silencers for reciprocating compressors, positive-displacement blowers, and naturally-aspirated or positively-scavenged gas or diesel engines . . . is featured in a new 6-pager. *Industrial Silencer Div., Burgess-Manning Co.*

Circle number (95) on reply card.

How To Apply To Your Business a new continuous electronic monitoring system . . . the Lynch B1020 . . . is told in a new 8-pager. The new high speed system can monitor any condition that can be represented by an electrical contact closure. *Lynch Communication Systems Inc.*

Circle number (96) on reply card.

Write for Bulletin

PIPELINE VENTS AND MARKERS

FLEET-LINE CO.
P. O. BOX 276-A
SHREVEPORT
LOUISIANA

NEW Arno®

PIPE-WRAP TAPE

Positive Protection for Buried Pipe

Here's pipe protection by the roll. Pipe-Wrap is made of stretchy, inert polyethylene with a pressure-sensitive adhesive to provide a tough, continuous barrier against rust, acids, alkalis and electrolytic currents. Saves time and money.

MANUFACTURERS AGENTS WANTED FOR SOME SELECTED AREAS

SEND FOR FREE SAMPLE

Arno® ADHESIVE TAPES, INC.
Dr. Scholl's Adhesive Tape Division
5118 Ohio Street, Michigan City, Indiana

Vermeer 4-T POW-R-DITCHER

Rugged, Low Cost Ditcher Digs 6"-14" Wide, 4½' Deep

This highly maneuverable 4T POW-R-DITCHER is only 46" wide . . . fast . . . and can handle most ditching jobs at a fraction of the cost of larger, more expensive units. The finest ditcher buy for low cost investment, low maintenance and high production.

IDEAL FOR LAYING GAS, WATER AND CABLE LINES AND FOR DIGGING HOME FOUNDATION FOOTINGS

PICK THE POW-R-DITCHER TO FIT YOUR NEEDS

524T

W-3

W-1

3P

Please send me FREE information and prices on the complete Vermeer line of self-propelled POW-R-DITCHERS.

NAME .....

FIRM .....

ADDRESS .....

CITY ..... STATE .....

☐ Also include information on new Vermeer hydraulic back filler.

VERMEER MANUFACTURING COMPANY
1443 WASHINGTON • PELLA, IOWA

How to CONTROL and ALARM the TOWER LIGHTS of UNATTENDED Microwave and Communication Stations

PHOTO ELECTRIC PANEL
Automatically turns Tower Lights ON and OFF in accordance with FCC regulations
FLASHER PANEL - Automatically Flashes Beacon Lamps — with balanced load provisions.
ALARM PANEL - Automatically provides signals indicating failure of any lamp, power or control.

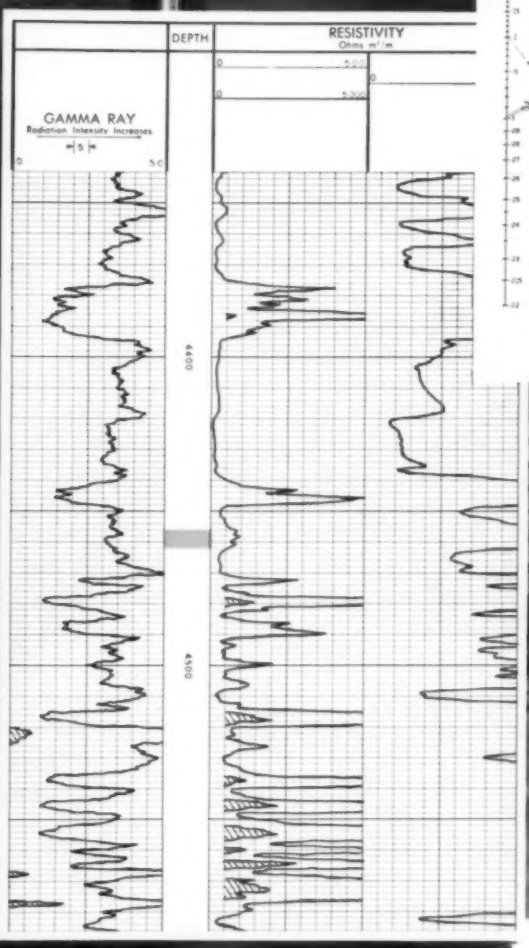
Model LC 201
TOWER LIGHTING CONTROL UNIT
(for Two Light Levels)
Model LC 101 (for Single Light Level)
Model LC 301 (for Three Light Levels)
Models also available with separate Alarm Signal for each Beacon Lamp.

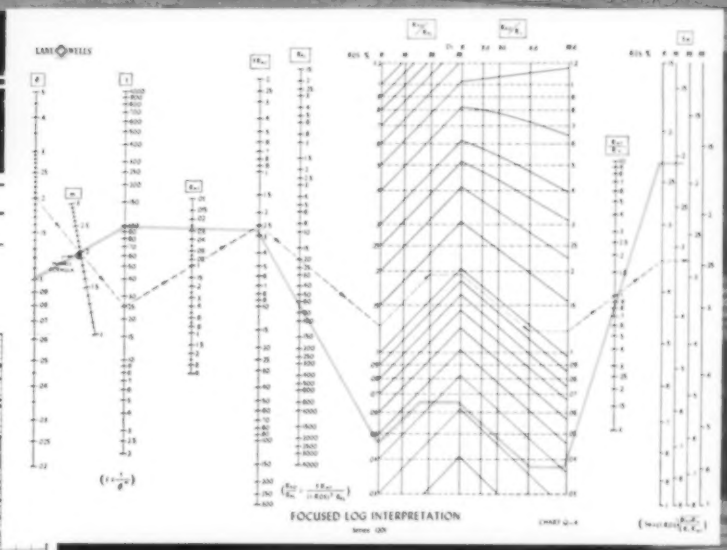
Write for descriptive Bulletins

HUGHEY & PHILLIPS, INC.

MANUFACTURERS OF
300MM Beacons, Obstruction Lights, Photo-Electric Controls, Beacon Flashers, Special Junction Boxes, Microwave Tower Light Control and alarm Systems, Tower Isolation Transformers, and Complete Kits for: Tower Lighting, Sleetmelter Power and Control.

3200 N. San Fernando Blvd. Burbank, Calif.





For resistivity determination in hard formations—salt muds

LANE-WELLS Focused Log

Maximum thin bed definition and depth of investigation
Reliability of measurements
Greatest linear dynamic range
More accuracy from new, improved interpretive aids

The Lane-Wells Focused Log provides optimum current focusing for reliable resistivity measurement. The flat current field gives excellent definition of beds down to one foot in thickness. Deep investigation obtains resistivity values requiring minimum correction.

The excellent reliability of this tool is the result of simplified design of the sub-surface instrumentation. Most of the electronic components required for measurement are placed in surface equipment where they are not subjected to the extremes of well temperature and running-in damage.

The Focused Log offers the greatest dynamic range of any available similar logging device, permitting linear measurement of resistivities to 5000 ohmmeters. Additional R_{xo} values on the interpretation chart provide more accurate Sw data.

A gamma ray curve may be run simultaneously for lithological correlation and other porosity devices may be used in combination for complete interpretation.

Ask your Lane-Wells representative for full information on this superior service, or write P. O. Box 1407, Houston 1, Texas.

LANE-WELLS CO.
P. O. BOX 1407 HOUSTON 1, TEXAS
DRESSER INDUSTRIES, INC.
OIL · GAS · CHEMICAL · ELECTRONIC · INDUSTRIAL

OPEN HOLE LOGGING • COMPLETION LOGGING • SIDE WALL CORING • PERFORATING
FORMATION TESTING • VIBRO-FRAC • BRIDGING PLUGS

AT ANY POINT IN THE FREE WORLD...

As offshore drilling expanded from the coasts of the United States to the waters of the free world, Halliburton expanded its operations to provide its services wherever they were needed.

Halliburton has left nothing undone to provide these offshore rigs in the far-flung waters of the world with the same excellence of products and services oil men have relied on for over 35 years.

As new pins are added to the offshore map of the Free World, they will also be pointing to new locations for Halliburton service.

Halliburton COMPANY · DUNCAN, OKLAHOMA